



British Guideline on the Management of Asthma

A national clinical guideline



May 2008
revised June 2009

NHS Quality Improvement Scotland (NHS QIS) is committed to equality and diversity. This guideline has been assessed for its likely impact on the six equality groups defined by age, disability, gender, race, religion/belief, and sexual orientation.

For the full equality and diversity impact assessment report please see the “published guidelines” section of the SIGN website at www.sign.ac.uk/guidelines/published/numlist.html. The full report in paper form and/or alternative format is available on request from the NHS QIS Equality and Diversity Officer.

British Thoracic Society
Scottish Intercollegiate Guidelines Network

British Guideline on the Management of Asthma

A national clinical guideline



**Royal College
of Physicians**
Setting higher medical standards

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SIGN and the BTS consent to the photocopying of this guideline for the purpose of implementation in the NHS in England, Wales, Northern Ireland and Scotland.

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KEY TO EVIDENCE STATEMENTS AND GRADES OF RECOMMENDATIONS

LEVELS OF EVIDENCE

- | | |
|-----------------|---|
| 1 ⁺⁺ | High quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias |
| 1 ⁺ | Well conducted meta-analyses, systematic reviews, or RCTs with a low risk of bias |
| 1 ⁻ | Meta-analyses, systematic reviews, or RCTs with a high risk of bias |
| 2 ⁺⁺ | High quality systematic reviews of case control or cohort studies
High quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal |
| 2 ⁺ | Well conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal |
| 2 | Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal |
| 3 | Non-analytic studies, eg case reports, case series |
| 4 | Expert opinion |

GRADES OF RECOMMENDATION

Note: The grade of recommendation relates to the strength of the evidence on which the recommendation is based. It does not reflect the clinical importance of the recommendation.

- | | |
|---|--|
| A | At least one meta-analysis, systematic review, or RCT rated as 1 ⁺⁺ , and directly applicable to the target population; or
A body of evidence consisting principally of studies rated as 1 ⁺ , directly applicable to the target population, and demonstrating overall consistency of results |
| B | A body of evidence including studies rated as 2 ⁺⁺ , directly applicable to the target population, and demonstrating overall consistency of results; or
Extrapolated evidence from studies rated as 1 ⁺⁺ or 1 ⁺ |
| C | A body of evidence including studies rated as 2 ⁺ , directly applicable to the target population and demonstrating overall consistency of results; or
Extrapolated evidence from studies rated as 2 ⁺⁺ |
| D | Evidence level 3 or 4; or
Extrapolated evidence from studies rated as 2 ⁺ |

GOOD PRACTICE POINTS

- | | |
|-------------------------------------|--|
| <input checked="" type="checkbox"/> | Recommended best practice based on the clinical experience of the guideline development group. |
| ❖ | Audit point |

1 Introduction

In 1999 the British Thoracic Society (BTS) and the Scottish Intercollegiate Guidelines Network (SIGN) agreed to jointly produce a comprehensive new asthma guideline, both having previously published guidance on asthma. The original BTS guideline dated back to 1990 and the SIGN guidelines to 1996. Both organisations recognised the need to develop the new guideline using explicitly evidence based methodology. The joint process was further strengthened by collaboration with Asthma UK, the Royal College of Physicians of London, the Royal College of Paediatrics and Child Health, the General Practice Airways Group, and the British Association of Accident and Emergency Medicine (now the College of Emergency Medicine). The outcome of these efforts was the British Guideline on the Management of Asthma published in 2003.¹

The 2003 guideline was developed using SIGN methodology,² adapted for UK-wide use. Electronic literature searches extended to 1995, although some sections required searches back as far as 1966. The pharmacological management section utilised the North of England Asthma guideline to address some of the key questions on adult management.³ The North of England guideline literature search covered a period from 1984 to December 1997, and SIGN augmented this with a search from 1997 onwards.

Since 2003 sections within the guideline have been updated annually and posted on both the BTS (www.brit-thoracic.org.uk) and SIGN (www.sign.ac.uk) websites. In 2004 the sections on pharmacological management, acute asthma and patient self management and compliance were revised. In 2005 sections on pharmacological management, inhaler devices, outcomes and audit and asthma in pregnancy were updated, and occupational asthma was rewritten with help from the British Occupational Health Research Foundation.

In 2006 the pharmacological management section was again updated. While the web-based alterations appeared successful, it was felt an appropriate time to consider producing a new paper-based version in which to consolidate the various yearly updates. In addition, since 2006, the guideline has had input from colleagues from Australia and New Zealand.

The 2008 guideline considered literature published up to March 2007. It contains a completely rewritten section on diagnosis for both adults and children; a section on special situations which includes occupational asthma, asthma in pregnancy and the new topic of difficult asthma; updated sections on pharmacological and non-pharmacological management; and amalgamated sections on patient education and compliance, and on organisation of care and audit. **The 2009 revisions include updates to pharmacological management, the management of acute asthma and asthma in pregnancy. Update searches were conducted on inhaler devices but there was insufficient new evidence to change the existing recommendations. The annexes have also been amended to reflect current evidence.** The timescale of the literature search for each section is given in Annex 1. It is hoped that this asthma guideline continues to serve as a basis for high quality management of both acute and chronic asthma and a stimulus for research into areas of management for which there is little evidence. Sections of the guideline will continue to be updated on the BTS and SIGN websites on an annual basis.



1.1 STATEMENT OF INTENT

This guideline is not intended to be construed or to serve as a standard of care. Standards of care are determined on the basis of all clinical data available for an individual case and are subject to change as scientific knowledge and technology advance and patterns of care evolve. Adherence to guideline recommendations will not ensure a successful outcome in every case, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgement must be made by the appropriate healthcare professional(s) responsible for clinical decisions regarding a particular clinical procedure or treatment plan. This judgement should only be arrived at following discussion of the options with the patient, covering the diagnostic and treatment choices available. It is advised, however, that significant departures from the national guideline or any local guidelines derived from it should be fully documented in the patient's case notes at the time the relevant decision is taken.

2 Diagnosis

The diagnosis of asthma is a clinical one; there is no standardised definition of the type, severity or frequency of symptoms, nor of the findings on investigation. The absence of a gold standard definition means that it is not possible to make clear evidence based recommendations on how to make a diagnosis of asthma.

Central to all definitions is the presence of symptoms (more than one of wheeze, breathlessness, chest tightness, cough) and of variable airflow obstruction. More recent descriptions of asthma in children and in adults have included airway hyper-responsiveness and airway inflammation as components of the disease. How these features relate to each other, how they are best measured and how they contribute to the clinical manifestations of asthma, remains unclear.

Although there are many shared features in the diagnosis of asthma in children and in adults there are also important differences. The differential diagnosis, the natural history of wheezing illnesses, the ability to perform certain investigations and their diagnostic value, are all influenced by age.

2.1 DIAGNOSIS IN CHILDREN

Asthma in children causes recurrent respiratory symptoms of:

- wheezing
- cough
- difficulty breathing
- chest tightness.

Wheezing is one of a number of respiratory noises that occur in children. Parents often use “wheezing” as a non-specific label to describe any abnormal respiratory noise. It is important to distinguish wheezing – a continuous, high-pitched musical sound coming from the chest – from other respiratory noises, such as stridor or rattly breathing.⁴

There are many different causes of wheeze in childhood and different clinical patterns of wheezing can be recognised in children. In general, these patterns (“phenotypes”) have been assigned retrospectively. They cannot reliably be distinguished when an individual child first presents with wheezing. In an individual child the pattern of symptoms may change as they grow older.

The commonest clinical pattern, especially in pre-school children and infants, is episodes of wheezing, cough and difficulty breathing associated with viral upper respiratory infections (colds), with no persisting symptoms. Most of these children will stop having recurrent chest symptoms by school age.

A minority of those who wheeze with viral infections in early life will go on to develop wheezing with other triggers so that they develop symptoms between acute episodes (interval symptoms) similar to older children with classical atopic asthma.⁵⁻⁹ 2⁺⁺

Children who have persisting or interval symptoms are most likely to benefit from therapeutic interventions.

2.1.1 MAKING A DIAGNOSIS IN CHILDREN

Initial clinical assessment

The diagnosis of asthma in children is based on recognising a characteristic pattern of episodic respiratory symptoms and signs (see *Table 1*) in the absence of an alternative explanation for them (see *Tables 2 and 3*).

Table 1: Clinical features that increase the probability of asthma

<p>More than one of the following symptoms: wheeze, cough, difficulty breathing, chest tightness, particularly if these symptoms:</p> <ul style="list-style-type: none"> ◇ are frequent and recurrent¹⁰⁻¹³ ◇ are worse at night and in the early morning^{11,12,14} ◇ occur in response to, or are worse after, exercise or other triggers, such as exposure to pets, cold or damp air, or with emotions or laughter ◇ occur apart from colds¹⁰ ▪ Personal history of atopic disorder^{10,13,15} ▪ Family history of atopic disorder and/or asthma^{10,16} ▪ Widespread wheeze heard on auscultation ▪ History of improvement in symptoms or lung function in response to adequate therapy
--

Table 2: Clinical features that lower the probability of asthma

<ul style="list-style-type: none"> ▪ Symptoms with colds only, with no interval symptoms¹⁰ ▪ Isolated cough in the absence of wheeze or difficulty breathing¹⁷ ▪ History of moist cough¹⁸ ▪ Prominent dizziness, light-headedness, peripheral tingling ▪ Repeatedly normal physical examination of chest when symptomatic ▪ Normal peak expiratory flow (PEF) or spirometry when symptomatic ▪ No response to a trial of asthma therapy¹⁹ ▪ Clinical features pointing to alternative diagnosis (see Table 3)

Several factors are associated with a high (or low) risk of developing persisting wheezing or asthma through childhood.^{15,20} The presence of these factors increases the probability that a child with respiratory symptoms will have asthma.

These factors include:

Age at presentation

The natural history of wheeze is dependent on age at first presentation. In general, the earlier the onset of wheeze, the better the prognosis. Cohort studies show a “break point” at around two years; most children who present before this age become asymptomatic by mid-childhood.^{6,8,9,21} Co-existent atopy is a risk factor for persistence of wheeze independent of age of presentation.

2⁺⁺

Sex

Male sex is a risk factor for asthma in pre-pubertal children. Female sex is a risk factor for the persistence of asthma in the transition from childhood to adulthood.^{22,23} Boys with asthma are more likely to “grow out” of their asthma during adolescence than girls.^{10,21,22,24-37}

Severity and frequency of previous wheezing episodes

Frequent or severe episodes of wheezing in childhood are associated with recurrent wheeze that persists into adolescence.^{5,8,13,16,21,26,38,39}

2⁺⁺

Coexistence of atopic disease

A history of other atopic conditions such as eczema and rhinitis increases the probability of asthma. Positive tests for atopy in a wheezing child also increase the likelihood of asthma. A raised specific IgE to wheat, egg white, or inhalant allergens such as house dust mite and cat dander, predicts later childhood asthma.^{40,41}

2++

Other markers of allergic disease at presentation, such as positive skin prick tests and a raised blood eosinophil count, are related to the severity of current asthma and persistence through childhood.

Family history of atopy

A family history of atopy is the most clearly defined risk factor for atopy and asthma in children. The strongest association is with maternal atopy, which is an important risk factor for the childhood onset of asthma and for recurrent wheezing that persists throughout childhood.^{6,34,37,42,43}

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Abnormal lung function

Persistent reductions in baseline airway function and increased airway responsiveness during childhood are associated with having asthma in adult life.²³

3

Table 3: Clinical clues to alternative diagnoses in wheezy children (features not commonly found in children with asthma)

Perinatal and family history	Possible diagnosis
Symptoms present from birth or perinatal lung problem	Cystic fibrosis; chronic lung disease of prematurity; ciliary dyskinesia; developmental anomaly
Family history of unusual chest disease	Cystic fibrosis; neuromuscular disorder
Severe upper respiratory tract disease	Defect of host defence; ciliary dyskinesia
Symptoms and signs	
Persistent moist cough ¹⁸	Cystic fibrosis; bronchiectasis; protracted bronchitis; recurrent aspiration; host defence disorder; ciliary dyskinesia
Excessive vomiting	Gastro-oesophageal reflux (\pm aspiration)
Dysphagia	Swallowing problems (\pm aspiration)
Breathlessness with light-headedness and peripheral tingling	Hyperventilation/panic attacks
Inspiratory stridor	Tracheal or laryngeal disorder
Abnormal voice or cry	Laryngeal problem
Focal signs in chest	Developmental anomaly; post-infective syndrome; bronchiectasis; tuberculosis
Finger clubbing	Cystic fibrosis; bronchiectasis
Failure to thrive	Cystic fibrosis; host defence disorder; gastro-oesophageal reflux
Investigations	
Focal or persistent radiological changes	Developmental anomaly; cystic fibrosis; post-infective disorder; recurrent aspiration; inhaled foreign body; bronchiectasis; tuberculosis

Case detection studies have used symptom questionnaires to screen for asthma in school-age children. A small number of questions - about current symptoms, their relation to exercise and their occurrence at night has been sufficient to detect asthma relatively efficiently.^{11,12,14,44} The addition of spirometry^{11,44} or bronchial hyper-responsiveness testing⁴⁵ to these questionnaires adds little to making a diagnosis of asthma in children. 2+

B Focus the initial assessment in children suspected of having asthma on:

- **presence of key features in the history and examination**
- **careful consideration of alternative diagnoses.**

- ☒ Record the basis on which a diagnosis of asthma is suspected.

2.1.2 ASSESSING THE PROBABILITY OF A DIAGNOSIS OF ASTHMA

Based on the initial clinical assessment it should be possible to determine the probability of a diagnosis of asthma.

With a thorough history and examination, an individual child can usually be classed into one of three groups (see *Figure 1*):

- **high probability** – diagnosis of asthma likely
- **low probability** – diagnosis other than asthma likely
- **intermediate probability** – diagnosis uncertain.

2.1.3 HIGH PROBABILITY OF ASTHMA

In children with a high probability of asthma based on the initial assessment, move straight to a diagnostic trial of treatment. The initial choice of treatment will be based on an assessment of the degree of asthma severity (see *section 4*).

The clinical response to treatment should be reassessed within 2-3 months. In this group, reserve more detailed investigations for those whose response to treatment is poor or those with severe disease.¹⁹

- ☒ In children with a high probability of asthma:
 - start a trial of treatment
 - review and assess response
 - reserve further testing for those with a poor response.

2.1.4 LOW PROBABILITY OF ASTHMA

Where symptoms, signs or initial investigations suggest that a diagnosis of asthma is unlikely, (see *Table 2*), or they point to an alternative diagnosis (see *Table 3*), consider further investigations. This may require referral for specialist assessment (see *Table 4*).

Reconsider a diagnosis of asthma in those who do not respond to specific treatments.

- ☒ In children with a low probability of asthma, consider more detailed investigation and specialist referral.

2.1.5 INTERMEDIATE PROBABILITY OF ASTHMA

In some children, and particularly those below the age of four to five, there is insufficient evidence at the first consultation to make a firm diagnosis of asthma, but no features to suggest an alternative diagnosis. There are several possible approaches to reaching a diagnosis in this group. Which approach is taken will be influenced by the frequency and severity of the symptoms.

These approaches include:

Watchful waiting with review

In children with mild, intermittent wheeze and other respiratory symptoms which occur only with viral upper respiratory infections (colds), it is often reasonable to give no specific treatment and to plan a review of the child after an interval agreed with the parents/carers.

Trial of treatment with review

The choice of treatment (for example, inhaled bronchodilators or corticosteroids) depends on the severity and frequency of symptoms. Although a trial of therapy with inhaled or oral corticosteroids is widely used to help make a diagnosis of asthma, there is little objective evidence to support this approach in children with recurrent wheeze.

It can be difficult to assess the response to treatment as an improvement in symptoms or lung function may be due to spontaneous remission. If it is unclear whether a child has improved, careful observation during a trial of withdrawing the treatment may clarify whether a response to asthma therapy has occurred.

Spirometry and reversibility testing

In children, as in adults, tests of airflow obstruction, airway responsiveness and airway inflammation may provide support for a diagnosis of asthma.^{12,44} However, normal results on testing, especially if performed when the child is asymptomatic, do not exclude a diagnosis of asthma.⁴⁶ Abnormal results may be seen in children with other respiratory diseases. Measuring lung function in young children is difficult and requires techniques which are not widely available.

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Above five years of age, conventional lung function testing is possible in most children in most settings. This includes measures of airway obstruction (spirometry and peak flow), reversibility with bronchodilators, and airway hyper-responsiveness.

The relationship between asthma symptoms and lung function tests including bronchodilator reversibility is complex. Asthma severity classified by symptoms and use of medicines correlates poorly with single measurements of forced expiratory volume in one second (FEV₁) and other spirometric indices: FEV₁ is often normal in children with persistent asthma.^{46,47} Serial measures of peak flow variability and FEV₁ show poor concordance with disease activity and do not reliably rule the diagnosis of asthma in or out.⁴⁷ Measures of gas trapping (residual volume and the ratio of residual volume to total lung capacity, RV/TLC) may be superior to measurements of expiratory flow at detecting airways obstruction especially in asymptomatic children.^{46,48}

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A significant increase in FEV₁ (>12% from baseline)⁴⁹ or PEF after bronchodilator indicates reversible airflow obstruction and supports the diagnosis of asthma. It is also predictive of a good response to inhaled corticosteroids.⁵⁰ However, an absent response to bronchodilators does not exclude asthma.⁵¹

2+
3

Between 2-5 years of age, many children can perform several newer lung function tests that do not rely on their cooperation or the ability to perform a forced expiratory manoeuvre. In general, these tests have not been evaluated as diagnostic tests for asthma. There is often substantial overlap between the values in children with and without asthma.⁵² Of the tests available, specific airways resistance (sRaw), impulse oscillometry (IOS), and measurements of residual volume (RV) appear the most promising.⁵³ While some of these tests have been useful in research, their role in clinical practice is uncertain.^{48,53,54} Most have only been used in specialist centres and are not widely available elsewhere. It is often not practical to measure variable airway obstruction in children below the age of five.

2+

2.1.6 CHILDREN WITH AN INTERMEDIATE PROBABILITY OF ASTHMA AND EVIDENCE OF AIRWAY OBSTRUCTION

Asthma is the by far the commonest cause of airways obstruction on spirometry in children. Obstruction due to other disorders, or due to multiple causes, is much less common in children than in adults. Spirometry and other lung function tests, including tests of PEF variability,⁴⁷ lung volumes and airway responsiveness,⁴⁵ are poor at discriminating between children with asthma and those with obstruction due to other conditions.

- ☑ In children with an intermediate probability of asthma who can perform spirometry and have evidence of airways obstruction, assess the change in FEV₁ or PEF in response to an inhaled bronchodilator (reversibility) and/or the response to a trial of treatment for a specified period:
 - if there is significant reversibility, or if a treatment trial is beneficial, a diagnosis of asthma is probable. Continue to treat as asthma, but aim to find the minimum effective dose of therapy. At a later point, consider a trial of reduction or withdrawal of treatment.
 - if there is no significant reversibility, and a treatment trial is not beneficial, consider tests for alternative conditions (see *Table 3*).

2.1.7 CHILDREN WITH AN INTERMEDIATE PROBABILITY OF ASTHMA WITHOUT EVIDENCE OF AIRWAY OBSTRUCTION

In this group, further investigations, including assessment of atopic status and bronchodilator responsiveness and if possible tests of airway responsiveness, should be considered (see *section 2.2.1*). This is particularly so if there has been a poor response to a trial of treatment or if symptoms are severe. In these circumstances, referral for specialist assessment is indicated.

- C** In children with an intermediate probability of asthma who can perform spirometry and have no evidence of airways obstruction:
 - consider testing for atopic status, bronchodilator reversibility and, if possible, bronchial hyper-responsiveness using methacholine, exercise or mannitol.
 - consider specialist referral.

2.1.8 CHILDREN WITH AN INTERMEDIATE PROBABILITY OF ASTHMA WHO CANNOT PERFORM SPIROMETRY

Most children under five years and some older children cannot perform spirometry. In these children, offer a trial of treatment for a specific period. If there is clear evidence of clinical improvement, the treatment should be continued and they should be regarded as having asthma (it may be appropriate to consider a trial of withdrawal of treatment at a later stage). If the treatment trial is not beneficial, then consider tests for alternative conditions and referral for specialist assessment.

- ☑ In children with an intermediate probability of asthma who cannot perform spirometry, offer a trial of treatment for a specified period:
 - if treatment is beneficial, treat as asthma and arrange a review
 - if treatment is not beneficial, stop asthma treatment and consider tests for alternative conditions and specialist referral.

2.2 OTHER INVESTIGATIONS

2.2.1 TESTS OF AIRWAY HYPER-RESPONSIVENESS

The role of tests of airway responsiveness (airway hyper-reactivity) in the diagnosis of childhood asthma is unclear.^{45,55} For example, a methacholine challenge test has a much lower sensitivity than symptoms in diagnosing asthma in children and only marginally increases the diagnostic accuracy after the symptom history is taken into account.⁴⁵ However, a negative methacholine test in children, which has a high negative predictive value, makes a diagnosis of asthma improbable.⁵⁵ Similarly, a negative response to an exercise challenge test is helpful in excluding asthma in children with exercise related breathlessness.⁵⁶

3

2.2.2 TEST OF EOSINOPHILIC AIRWAY INFLAMMATION

Eosinophilic inflammation in children can be assessed non-invasively using induced sputum differential eosinophil count or exhaled nitric oxide concentrations (F_{ENO}).

Sputum induction is feasible in school age children.^{57,58} Higher sputum eosinophil counts are associated with more marked airways obstruction and reversibility, greater asthma severity and atopy.⁵⁹ In children with newly diagnosed mild asthma, sputum eosinophilia is present and declines with inhaled steroid treatment.⁵⁸ Sputum induction is possible in approximately 75% of children tested, but it is technically demanding and time consuming and at present remains a research tool.

2⁺⁺

It is feasible to measure F_{ENO} in unsedated children from the age of 3-4 years.⁶⁰ A raised F_{ENO} is neither a sensitive nor a specific marker of asthma with overlap with children who do not have asthma.⁶¹ F_{ENO} is closely linked with atopic status, age and height.^{62,63} In some studies, F_{ENO} correlated better with atopic dermatitis and allergic rhinitis than with asthma. It is not closely linked with underlying lung function. F_{ENO} could not differentiate between groups once atopy was taken into account.⁶⁴ Home measurements of F_{ENO} have a highly variable relationship with other measures of disease activity and vary widely from day to day.⁶⁵

2⁺

At present, there is insufficient evidence to support a role for markers of eosinophilic inflammation in the diagnosis of asthma in children. They may have a role in assessing severity of disease or response to treatment.

2.2.3 TESTS OF ATOPY

Positive skin tests,⁶⁶ blood eosinophilia $\geq 4\%$ ¹⁰, or a raised specific IgE to cat, dog or mite,^{67,68} increase the probability of asthma in a child with wheeze, particularly in children over five years of age.⁶⁶ It is important to recognise that non-atopic wheezing is as frequent as atopic wheezing in school-age children.⁶⁹

2⁺⁺

2.2.4 CHEST X-RAY

A study in primary care in children age 0-6 years concluded that a chest X-ray (CXR), in the absence of a clinical indication, need not be part of the initial diagnostic work up.⁷⁰



Reserve chest X-rays for children with severe disease or clinical clues suggesting other conditions.

2.3 SUMMARY

Focus the initial assessment of children suspected of having asthma on:

- presence of key features in the history and clinical examination
- careful consideration of alternative diagnoses.

Record the basis on which the diagnosis of asthma is suspected.

Using a structured questionnaire may produce a more standardised approach to the recording of presenting clinical features and the basis for a diagnosis of asthma.

1. In children with a high probability of asthma:

- move straight to a trial of treatment
- reserve further testing for those with a poor response.

2. In children with a low probability of asthma:

- consider more detailed investigation and specialist referral.

3. In children with an intermediate probability of asthma who can perform spirometry and have evidence of airways obstruction, offer a reversibility test and/or a trial of treatment for a specified period:

- if there is reversibility, or if treatment is beneficial, treat as asthma
- if there is insignificant reversibility, and/or treatment trial is not beneficial, consider tests for alternative conditions.

4. In children with an intermediate probability of asthma who can perform spirometry, and have no evidence of airways obstruction, consider testing for atopic status, bronchodilator reversibility and, if possible, bronchial hyper-responsiveness using methacholine or exercise.

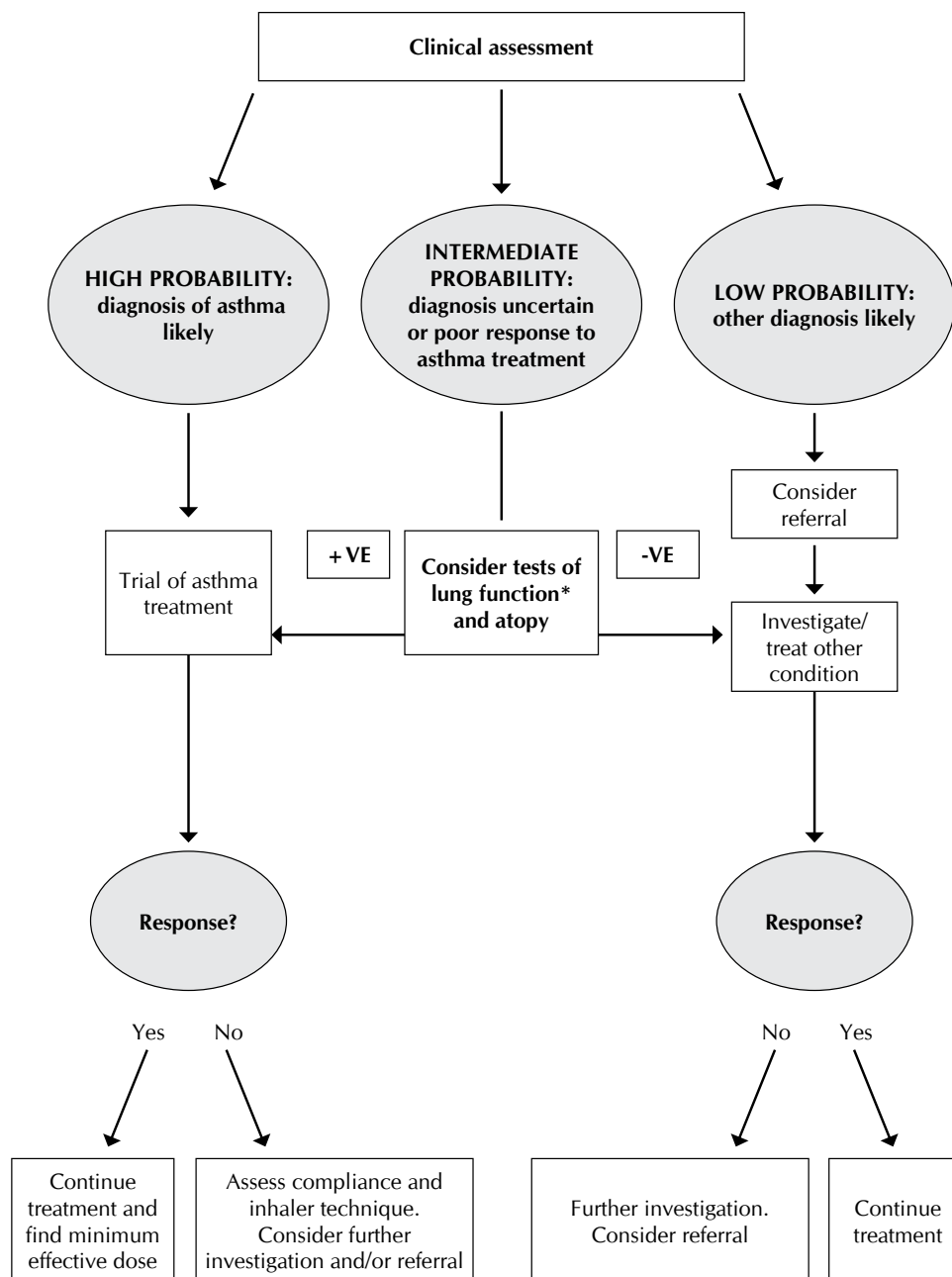
5. In children with an intermediate probability of asthma, who cannot perform spirometry, consider testing for atopic status and offering a trial of treatment for a specified period:

- if treatment is beneficial, treat as asthma
- if treatment is not beneficial, stop asthma treatment, and consider tests for alternative conditions and specialist referral.

Table 4: Indications for specialist referral in children

- Diagnosis unclear or in doubt
- Symptoms present from birth or perinatal lung problem
- Excessive vomiting or possetting
- Severe upper respiratory tract infection
- Persistent wet or productive cough
- Family history of unusual chest disease
- Failure to thrive
- Nasal polyps
- Unexpected clinical findings eg focal signs, abnormal voice or cry, dysphagia, inspiratory stridor
- Failure to respond to conventional treatment (particularly inhaled corticosteroids above 400 mcg/day or frequent use of steroid tablets)
- Parental anxiety or need for reassurance

Figure 1: Presentation with suspected asthma in children



* Lung function tests include spirometry before and after bronchodilator (test of airway reversibility) and possible exercise or methacholine challenge (tests of airway responsiveness). Most children over the age of 5 years can perform lung function tests.

2.4 DIAGNOSIS IN ADULTS

The diagnosis of asthma is based on the recognition of a characteristic pattern of symptoms and signs and the absence of an alternative explanation for them (see *Table 5*). The key is to take a careful clinical history. In many cases this will allow a reasonably certain diagnosis of asthma, or an alternative diagnosis, to be made. If asthma does appear likely, the history should also explore possible causes, particularly occupational.

In view of the potential requirement for treatment over many years, it is important even in relatively clear cut cases, to try to obtain objective support for the diagnosis. Whether or not this should happen before starting treatment depends on the certainty of the initial diagnosis and the severity of presenting symptoms. Repeated assessment and measurement may be necessary before confirmatory evidence is acquired.

Confirmation hinges on demonstration of airflow obstruction varying over short periods of time. Spirometry, which is now becoming more widely available, is preferable to measurement of peak expiratory flow because it allows clearer identification of airflow obstruction, and the results are less dependent on effort. It should be the preferred test where available (although some training is required to obtain reliable recordings and to interpret the results). Of note, a normal spirogram (or PEF) obtained when the patient is not symptomatic does not exclude the diagnosis of asthma.

Results from spirometry are also useful where the initial history and examination leave genuine uncertainty about the diagnosis. In such cases, the differential diagnosis and approach to investigation is different in patients with and without airflow obstruction (see *Figure 2 and Table 6*). In patients with a normal or near-normal spirogram when symptomatic, potential differential diagnoses are mainly non-pulmonary;^{71,72} these conditions do not respond to inhaled corticosteroids and bronchodilators. In contrast, in patients with an obstructive spirogram the question is less whether they will need inhaled treatment but rather exactly what form and how intensive this should be.

Other tests of airflow obstruction, airway responsiveness and airway inflammation can also provide support for the diagnosis of asthma, but to what extent the results of the tests alter the probability of a diagnosis of asthma has not been clearly established, nor is it clear when these tests are best performed.

Table 5: Clinical features in adults that influence the probability that episodic respiratory symptoms are due to asthma

Features that increase the probability of asthma
<ul style="list-style-type: none"> ▪ More than one of the following symptoms: wheeze, breathlessness, chest tightness and cough, particularly if: <ul style="list-style-type: none"> ◊ symptoms worse at night and in the early morning ◊ symptoms in response to exercise, allergen exposure and cold air ◊ symptoms after taking aspirin or beta blockers ▪ History of atopic disorder ▪ Family history of asthma and/or atopic disorder ▪ Widespread wheeze heard on auscultation of the chest ▪ Otherwise unexplained low FEV₁ or PEF (historical or serial readings) ▪ Otherwise unexplained peripheral blood eosinophilia
Features that lower the probability of asthma
<ul style="list-style-type: none"> ▪ Prominent dizziness, light-headedness, peripheral tingling ▪ Chronic productive cough in the absence of wheeze or breathlessness ▪ Repeatedly normal physical examination of chest when symptomatic ▪ Voice disturbance ▪ Symptoms with colds only ▪ Significant smoking history (ie > 20 pack-years) ▪ Cardiac disease ▪ Normal PEF or spirometry when symptomatic* <p>* A normal spirogram/spirometry when not symptomatic does not exclude the diagnosis of asthma. Repeated measurements of lung function are often more informative than a single assessment.</p>

- ☒ Base initial diagnosis on a careful assessment of symptoms and a measure of airflow obstruction:
- in patients with a high probability of asthma move straight to a trial of treatment. Reserve further testing for those whose response to a trial of treatment is poor.
 - in patients with a low probability of asthma, whose symptoms are thought to be due to an alternative diagnosis, investigate and manage accordingly. Reconsider the diagnosis of asthma in those who do not respond.
 - the preferred approach in patients with an intermediate probability of having asthma is to carry out further investigations, including an explicit trial of treatments for a specified period, before confirming a diagnosis and establishing maintenance treatment.

D Spirometry is the preferred initial test to assess the presence and severity of airflow obstruction.

2.4.1 FURTHER INVESTIGATION OF PATIENTS WITH AN INTERMEDIATE PROBABILITY OF ASTHMA

Patients with airways obstruction

Tests of peak expiratory flow variability, lung volumes, gas transfer, airway hyper-responsiveness and airway inflammation are of limited value in discriminating patients with established airflow obstruction due to asthma from those whose airflow obstruction is due to other conditions.⁷³⁻

⁷⁶ Patients may have more than one cause of airflow obstruction, which complicates the interpretation of any test. In particular, asthma and chronic obstructive pulmonary disease (COPD) commonly coexist.

- ☒ Offer patients with airways obstruction and intermediate probability of asthma a reversibility test and/or a trial of treatment for a specified period:
 - if there is significant reversibility, or if a treatment trial is clearly beneficial treat as asthma
 - if there is insignificant reversibility and a treatment trial is not beneficial, consider tests for alternative conditions.*

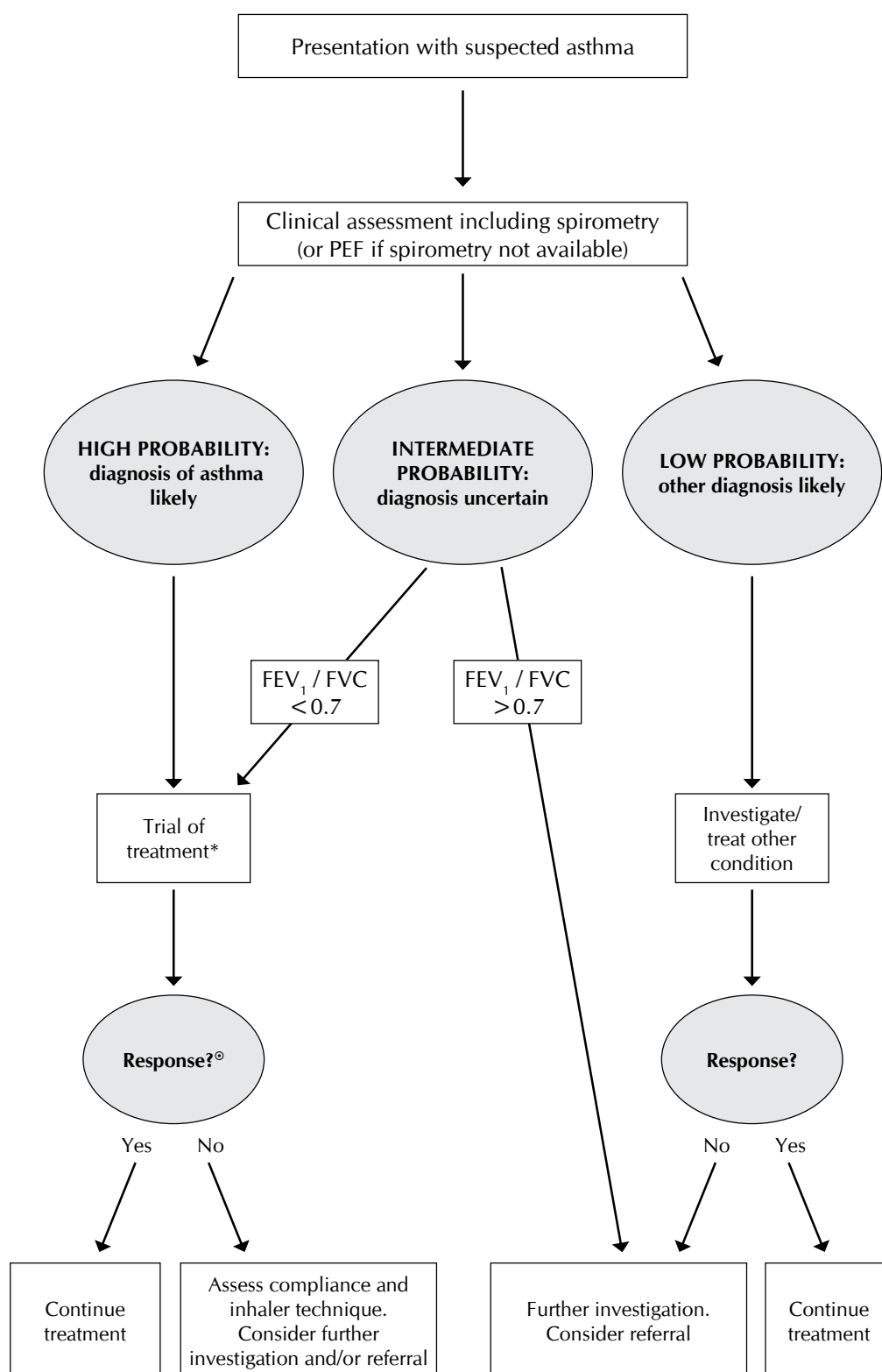
Patients without airways obstruction

In patients with a normal or near-normal spirogram it is more useful to look for evidence of airway hyper-responsiveness and/or airway inflammation ^{71,77-79} These tests are sensitive so normal results provide the strongest evidence against a diagnosis of asthma.

- ☒ In patients without evidence of airways obstruction and with an intermediate probability of asthma, arrange further investigations* before commencing treatment.

* see section 2.5 for more detailed information on further tests

Figure 2: Presentation with suspected asthma in adults



* See section 2.5.1

® See Table 6

Table 6: Differential diagnosis of asthma in adults, according to the presence or absence of airflow obstruction ($FEV_1/FVC < 0.7$).

Without airflow obstruction
<ul style="list-style-type: none"> ▪ Chronic cough syndromes ▪ Hyperventilation syndrome ▪ Vocal cord dysfunction ▪ Rhinitis ▪ Gastro-oesophageal reflux ▪ Heart failure ▪ Pulmonary fibrosis
With airflow obstruction
<ul style="list-style-type: none"> ▪ COPD ▪ Bronchiectasis* ▪ Inhaled foreign body* ▪ Obliterative bronchiolitis ▪ Large airway stenosis ▪ Lung cancer* ▪ Sarcoidosis* <p>*may also be associated with non-obstructive spirometry</p>

- ☒ Consider performing chest X-ray in any patient presenting atypically or with additional symptoms or signs. Additional investigations such as full lung function tests, blood eosinophil count, serum IgE and allergen skin prick tests may be of value in selected patients.

Criteria for referral to a specialist are outlined in box 1.

Box 1: Criteria for specialist referral in adults

- Diagnosis unclear
- Unexpected clinical findings (ie crackles, clubbing, cyanosis, cardiac disease)
- Unexplained restrictive spirometry
- Suspected occupational asthma
- Persistent non-variable breathlessness
- Monophonic wheeze or stridor
- Prominent systemic features (myalgia, fever, weight loss)
- Chronic sputum production
- CXR shadowing
- Marked blood eosinophilia ($> 1 \times 10^9/l$)
- Poor response to asthma treatment
- Severe asthma exacerbation

2.5 FURTHER INVESTIGATIONS THAT MAY BE USEFUL IN PATIENTS WITH AN INTERMEDIATE PROBABILITY OF ASTHMA

Three studies have looked at tests to discriminate patients with asthma from those with conditions that are commonly confused with asthma.^{71,77,79} These studies provide a basis for evaluating the diagnostic value of different tests. Table 7 summarises the sensitivity and specificity of different findings on investigation. As not all studies included patients with untreated asthma, these values may underestimate the value of the investigations in clinical practice, where many patients will be investigated before treatment is started. The diagnostic value of testing may also be greater when more than one test is done or if there are previous lung function results available in the patient's notes. The choice of test will depend on a number of factors including severity of symptoms and local availability of tests.

An alternative and promising approach to the classification of airways disease is to use tests which best identify patients who are going to respond to corticosteroid therapy.^{78,80} A raised sputum eosinophil count and an increased exhaled nitric oxide concentration (FENO) are more closely related to corticosteroid response than other tests in a variety of clinical settings.^{78,81-83} There is also evidence that markers of eosinophilic airway inflammation are of value in monitoring the response to corticosteroid treatment.⁸⁴⁻⁸⁶ More experience with these techniques and more information on the long term response to corticosteroid in patients who do not have a raised sputum eosinophil count or FENO is needed before this approach can be recommended.

Table 7: Estimates of sensitivity and specificity of test results in adults with suspected asthma and normal or near-normal spirometric values.^{71,77,79}

Test	Normal range	Validity	
		sensitivity	specificity
Methacholine PC ₂₀	> 8 mg/ml	High	Medium
Indirect challenges*	varies	Medium [#]	High
FENO	< 25ppb	High [#]	Medium
Sputum eosinophil count	< 2%	High [#]	Medium
PEF A%H	< 8** < 20%***	Low	Medium

PC₂₀ = the provocative concentration of methacholine required to cause a 20% fall in FEV₁. FENO = exhaled nitric oxide concentration. PEF A%H = peak expiratory flow amplitude percent highest.

*ie exercise challenge, inhaled mannitol [#] in untreated patients, **with twice daily readings
***with four or more readings

2.5.1 TREATMENT TRIALS AND REVERSIBILITY TESTING

Treatment trials with bronchodilators or inhaled corticosteroids in patients with diagnostic uncertainty should use one or more objective methods of assessment. Using spirometric values or PEF as the prime outcome of interest is of limited value in patients with normal or near-normal pre-treatment lung function since there is little room for measurable improvement. One study has shown that the sensitivity of a positive response to inhaled corticosteroid, defined as a > 15% improvement in PEF, is 24%.⁷⁹ A variety of tools to assess asthma control is available to assess the response to a trial of treatment (see Table 8).

2⁺

Using FEV₁ or PEF as the primary method to assess reversibility or the response to treatment trials may be more helpful in patients with established airflow obstruction.

In adults, most clinicians would try a 6-8 week treatment trial of 200 mcg inhaled beclometasone (or equivalent) twice daily. In patients with significant airflow obstruction there may be a degree of inhaled corticosteroid resistance⁸⁷ and a treatment trial with oral prednisolone 30 mg daily for two weeks is preferred.

2⁺

A > 400 ml improvement in FEV_1 to either β_2 agonists or corticosteroid treatment trials strongly suggests underlying asthma. Smaller improvements in FEV_1 are less discriminatory⁷¹ and a decision on continuation of treatment should be based on objective assessment of symptoms using validated tools (see *Table 8*). Trials of treatment withdrawal may be helpful where there is doubt. 2+

C

Assess FEV_1 (or PEF) and/or symptoms:

- **before and after 400 mcg inhaled salbutamol in patients with diagnostic uncertainty and airflow obstruction present at the time of assessment**
- **in other patients, or if there is an incomplete response to inhaled salbutamol, after either inhaled corticosteroids (200 mcg twice daily beclometasone equivalent for 6-8 weeks) or oral prednisolone (30 mg once daily for 14 days).**

2.5.2 PEAK EXPIRATORY FLOW MONITORING

PEF should be recorded as the best of three forced expiratory blows from total lung capacity with a maximum pause of two seconds before blowing.⁸⁸ The patient can be standing or sitting. Further blows should be done if the largest two PEF are not within 40 l/min.⁸⁸

PEF is best used to provide an estimate of variability of airflow from multiple measurements made over at least two weeks. Increased variability may be evident from twice daily readings. More frequent readings will result in a better estimate⁸⁹ but the improved precision is likely to be achieved at the expense of reduced patient compliance.⁹⁰

PEF variability is best calculated as the difference between the highest and lowest PEF expressed as a percentage of either the mean or highest PEF.⁹¹⁻⁹³

The upper limit of the normal range for the amplitude % highest is around 20% using four or more PEF readings per day^{91,93,94} but may be lower using twice daily readings.⁹⁵ Epidemiological studies have shown sensitivities of between 19 and 33% for identifying physician-diagnosed asthma.^{92,96}

PEF variability can be increased in patients with conditions commonly confused with asthma^{71,73} so the specificity of abnormal PEF variability is likely to be less in clinical practice than it is in population studies.

PEF records from frequent readings taken at work and away from work are useful when considering a diagnosis of occupational asthma (see *section 7.8*). A computer generated analysis of occupational records which provides an index of the work effect is available.⁹⁷



Peak flow records should be interpreted with caution and with regard to the clinical context. They are more useful in the monitoring of patients with established asthma than in making the initial diagnosis.

2.5.3 ASSESSMENT OF AIRWAY RESPONSIVENESS

Tests of airway responsiveness have been useful in research but are not yet widely available in everyday clinical practice. The most widely used method of measuring airway responsiveness relies on measuring response in terms of change in FEV_1 a set time after inhalation of increasing concentrations of histamine or methacholine. The agent can be delivered by breath-activated dosimeter, via a nebuliser using tidal breathing, or via a hand held atomiser.⁹⁸ The response is usually quantified as the concentration (or dose) required to cause a 20% fall in FEV_1 (PC_{20} or PD_{20}) calculated by linear interpolation of the log concentration or dose-response curve.

Community studies in adults have consistently shown that airway responsiveness has a unimodal distribution with between 90 and 95% of the normal population having a histamine or methacholine PC_{20} of > 8 mg/ml (equivalent to a PD_{20} of > 4 micromoles).^{92,99,100} This value has a sensitivity of between 60-100% in detecting physician-diagnosed asthma.^{92,96,99,100}

In patients with normal or near-normal spirometric values, assessment of airway responsiveness is significantly better than other tests in discriminating patients with asthma from patients with conditions commonly confused with asthma (see *Table 6*).^{71,77} In contrast, tests of airway responsiveness are of little value in patients with established airflow obstruction as the specificity is low.^{73,76}

Other potentially helpful constrictor challenges include indirect challenges such as inhaled mannitol and exercise.¹⁰¹ A positive response to these indirect stimuli (ie a > 15% fall in FEV₁) is a specific indicator of asthma but the tests are less sensitive than tests using methacholine and histamine, particularly in patients tested while on treatment.^{101,102}

2.5.4 TESTS OF EOSINOPHILIC AIRWAY INFLAMMATION

Eosinophilic airway inflammation can be assessed non-invasively using the induced sputum differential eosinophil count or the exhaled nitric oxide concentration (FENO).^{103,104} A raised sputum eosinophil count (> 2%) or FENO (> 25 ppb at 50 ml/sec) is seen in 70-80% of patients with untreated asthma.^{74,103} Neither finding is specific to asthma: 30-40% of patients with chronic cough^{82,105,106} and a similar proportion of patients with COPD⁸¹ have abnormal results. There is growing evidence that measures of eosinophilic airway inflammation are more closely linked to a positive response to corticosteroids than other measures even in patients with diagnoses other than asthma.^{81,83,105}

Experience with induced sputum and FENO is limited to a few centres and more research needs to be done before any recommendations can be made.

C

In patients in whom there is diagnostic uncertainty and no evidence of airflow obstruction on initial assessment, test airway responsiveness wherever possible.

2.6 MONITORING ASTHMA

In the majority of patients with asthma symptom-based monitoring is adequate. Patients achieving control of symptoms with treatment have a low risk for exacerbations.¹⁰⁷

Table 8 summarises the methodology, measurement characteristics and interpretation of some of the validated tools used to assess symptoms and other aspects of asthma. Some measures provide information about future risk (ie sputum eosinophil count, airway responsiveness and FENO) rather than immediate clinical control. Risk reduction, eg minimising future adverse outcomes such as exacerbations and accelerated decline in lung function, is also a goal of asthma management.

A management strategy that controls eosinophilic airway inflammation⁸⁴⁻⁸⁶ or airway hyper-responsiveness¹⁰⁸ results in better control of exacerbations than one which controls immediate clinical manifestations. The benefits of this more intensive approach are greater in patients with severe asthma, when exacerbations can occur frequently and unpredictably. More research is needed to assess the relative roles of the different measures and to address the feasibility and cost of incorporating them into monitoring protocols before they can be recommended more widely.

2.6.1 MONITORING IN PRIMARY CARE

Asthma is best monitored in primary care by routine clinical review on at least an annual basis (see *section 8.1.2*).

The factors that should be monitored and recorded include:

- symptomatic asthma control: best assessed using directive questions such as the RCP '3 questions',¹⁰⁹ or the Asthma Control Questionnaire or Asthma Control Test (see *Table 8*), since broad non-specific questions may underestimate symptoms
- lung function, assessed by spirometry or by PEF. Reduced lung function compared to previously recorded values may indicate current bronchoconstriction or a long term decline in lung function and should prompt detailed assessment
- exacerbations, oral corticosteroid use and time off work or school since last assessment
- inhaler technique (see *section 5*)
- compliance (see *section 9.2*) which can be assessed by reviewing prescription refill frequency
- bronchodilator reliance which can be assessed by reviewing prescription refill frequency
- possession of and use of self management plan/personal action plan (see *section 9.1*).

Table 8: Summary of tools that can be used to assess asthma.

Measurement	Methodology	Measurement characteristics	Comments
Spirometry ^{110, 111}	<p>Widely available.</p> <p>Enables clear demonstration of airflow obstruction.</p> <p>FEV₁ largely independent of effort and highly repeatable.</p> <p>Less applicable in acute severe asthma. Only assesses one aspect of the disease state.</p>	<p>Normal ranges widely available and robust.</p> <p>Short term (20 minute) 95% range for repeat measure of FEV₁ < 160 ml; FVC < 330 ml, independent of baseline value.</p>	<p>Good for short and longer term reversibility testing in subjects with pre-existing airflow obstruction.</p> <p>> 400 ml increase in FEV₁ highly suggestive of asthma.</p> <p>Less helpful in subjects with normal pre-treatment values because of ceiling effect.</p>
Peak expiratory flow (PEF) ^{88, 91, 92, 112}	<p>Widely available and simple.</p> <p>Applicable in a wide variety of circumstances including acute severe asthma.</p> <p>PEF variability can be determined from home readings in most subjects.</p> <p>PEF effort dependent and not as repeatable as FEV₁.</p> <p>Only assesses one aspect of the disease state.</p>	<p>Normal ranges of PEF are wide, and currently available normative tables are outdated and do not encompass ethnic diversity.</p> <p>Change in PEF more meaningful than absolute value.</p> <p>> 60 l/min increase in PEF suggested as best criteria for defining reversibility.</p> <p>Normal range of PEF variability defined as amplitude % highest < 8% or < 20% depending on number of readings and degree of patient coaching.</p>	<p>Useful for short and longer term reversibility testing in subjects with pre-existing airflow obstruction.</p> <p>Less helpful in subjects with normal pre-treatment values because of ceiling effect.</p> <p>Little information on the use of PEF variability as an index of treatment response.</p>

Measurement	Methodology	Measurement characteristics	Comments
Royal College of Physicians (RCP) 3 Questions ¹⁰⁹	<p>Yes/no or graded response to the following three questions:</p> <p>In the last week (or month)</p> <p>1. Have you had difficulty sleeping because of your asthma symptoms (including cough)?</p> <p>2. Have you had your usual asthma symptoms during the day (cough, wheeze, chest tightness or breathlessness)?</p> <p>3. Has your asthma interfered with your usual activities (eg housework, work/school etc)?</p>	No to all questions consistent with controlled asthma.	<p>Not well validated.</p> <p>Simplicity is attractive for use in day to day clinical practice.</p>
Asthma Control Questionnaire ¹¹³⁻¹¹⁵	<p>Response to 7 questions, 5 relating to symptoms, 1 rescue treatment use and 1 FEV₁.</p> <p>Response usually assessed over the preceding week.</p> <p>Shortened, five question symptom only questionnaire is just as valid.</p>	<p>Well controlled ≤ 0.75, inadequately controlled ≥ 1.5.</p> <p>95% range for repeat measure ± 0.36.</p> <p>Minimal important difference 0.5.</p>	<p>Well validated composite scoring system with a strong bias to symptoms.</p> <p>Could be used to assess response to longer term treatment trials.</p> <p>Shortened five-point questionnaire is probably best for those with normal or near normal FEV₁.</p>
Asthma Control Test (ACT) ^{116, 117}	<p>Response to 5 questions, 3 related to symptoms, 1 medication use and 1 overall control. 5 point response score</p>	<p>Well controlled > 19.</p> <p>Within subject intraclass correlation coefficient 0.77.</p> <p>95% range for repeat measure and minimally clinically important difference not defined.</p>	<p>Could be used to assess response to longer term treatment trials, particularly in those with normal or near-normal spirometric values.</p> <p>95% range for repeat measure and minimally clinically important difference need to be defined.</p>

Measurement	Methodology	Measurement characteristics	Comments
Mini Asthma Quality of Life Questionnaire (AQLQ) ^{114, 118}	<p>Response to 15 questions in 4 domains (symptoms, activity limitations, emotional function and environmental stimuli).</p> <p>Response usually assessed over the preceding week. Closely related to larger 32-item asthma quality of life questionnaire.</p>	<p>95% range for repeat measure +/- 0.36.</p> <p>Minimal important difference 0.5.</p>	<p>Well validated quality of life questionnaire.</p> <p>Could be used to assess response to longer term treatment trials.</p>
Airway responsiveness ^{98, 108}	<p>Only available in selected secondary care facilities.</p> <p>Responsive to change (particularly indirect challenges such as inhaled mannitol).</p> <p>Less of a ceiling effect.</p> <p>Not applicable in severe asthma or in acute severe asthma</p>	<p>Normal methacholine PC₂₀ > 8 mg/ml.</p> <p>95% range for repeat measure +/- 1.5-2 doubling doses.</p>	<p>Has not been widely used to monitor disease and assess treatment responses.</p> <p>Some evidence that using airway responsiveness as an additional measure for monitoring asthma results in a reduction in asthma exacerbations and improved airway pathology.</p>

Measurement	Methodology	Measurement characteristics	Comments
Exhaled nitric oxide (F _{ENO}) ^{78, 85, 103, 119, 120}	<p>Not widely available.</p> <p>Monitors still expensive, although expect the technology to become cheaper and more widespread.</p> <p>Measurements can be obtained in almost all adults and children over 5 years.</p> <p>Immediate results are available.</p> <p>Reasonably close relationship between F_{ENO} and eosinophilic airway inflammation, which is independent of gender, age, atopy and inhaled corticosteroid use.</p> <p>Relationship is lost in smokers.</p> <p>Not closely related to other measures of asthma morbidity.</p>	<p>Normal range < 25 ppb at exhaled flow of 50 ml/sec. 95% range for repeat measure 4 ppb.</p> <p>> 50 ppb highly predictive of eosinophilic airway inflammation.</p> <p>< 25 ppb highly predictive of its absence.</p>	<p>Raised F_{ENO} (> 50 ppb) very predictive of a positive response to corticosteroids.</p> <p>Use of F_{ENO} to guide corticosteroid treatment has been shown to result in a non-significant 25% reduction in exacerbations with 40% less corticosteroid.</p> <p>Low F_{ENO} (< 25 ppb) may be of particular value in identifying patients who can step down corticosteroid treatment safely.</p> <p>Protocols for diagnosis and monitoring have not been well defined and experience with the technique is limited.</p>
Sputum eosinophil differential count ^{83, 84, 121, 122}	<p>Only available in specialist centres although technology is widely available and inexpensive.</p> <p>Information available in 80-90% of patients although immediate results are not available.</p> <p>Sputum eosinophil count not closely related to other measures of asthma morbidity</p>	<p>Normal range < 2%; 95% range for repeat measure +/- 2-3 fold.</p>	<p>Close relationship between raised sputum eosinophil count and corticosteroid responsiveness.</p> <p>Use of sputum eosinophil count to guide corticosteroid therapy has been consistently shown to result in better outcome for the same exposure to corticosteroids.</p> <p>Benefits are greater in patients with more severe disease.</p>

3 Non-pharmacological management

There is a common perception amongst patients and carers that there are numerous environmental, dietary and other triggers of asthma and that avoiding these triggers will improve asthma and reduce the requirement for pharmacotherapy. Failure to address a patient, parent or carer's concern about environmental triggers may compromise concordance with recommended pharmacotherapy. Evidence that non-pharmacological management is effective can be difficult to obtain and more well controlled intervention studies are required.

This section distinguishes:

1. primary prophylaxis - interventions introduced before the onset of disease and designed to reduce its incidence.
2. secondary prophylaxis - interventions introduced after the onset of disease to reduce its impact.

3.1 PRIMARY PROPHYLAXIS

The evidence for primary interventional strategies is based predominantly on observational studies, though some have been tested using experimental methods. Many are multifaceted and it can be difficult to disentangle the effects of one exposure or intervention from another.

3.1.1 AEROALLERGEN AVOIDANCE

Exposure to high levels of house dust mite allergen in early life is associated with an increased likelihood of sensitisation to house dust mite by three to seven years of age.¹²³ Sensitisation to house dust mite is an important risk factor for the development of asthma^{124,125} and a few studies have suggested that high early house dust mite exposure increases the risks of subsequent asthma.^{126,127} A UK study showed that low levels of house dust mite and cat allergen exposures in early life increased the risk of IgE sensitisation and asthma at five years, with some attenuation at high levels of exposure, but there were significant interactions with heredity and birth order.¹²⁸

Outcomes from intervention studies attempting to reduce exposure to house dust mites are inconsistent. A multifaceted Canadian intervention study showed a reduced prevalence of doctor-diagnosed asthma but no impact on other allergic diseases, positive skin prick tests or bronchial hyper-responsiveness;¹²⁹ others have shown no effect on either allergic sensitisation or symptoms of allergic diseases.¹³⁰ In one UK study, early results from environmental manipulation commenced in early pregnancy and focused mainly on house dust mite avoidance, showed reductions in some respiratory symptoms in the first year of life.¹³¹ Subsequent results showed a paradoxical effect with increased allergy but better lung function in the intervention group.¹³²

1+

The considerable variation in the methodology used in these studies precludes the merging of data or generation of meta-analyses.

Intensive house dust mite avoidance may reduce exposure to a range of other factors including endotoxin. Epidemiological studies suggest that close contact with a cat or a dog in early life may reduce the subsequent prevalence of allergy and asthma.^{133,134} This has raised the question of whether high pet allergen exposure causes high-dose immune tolerance or increases exposure to endotoxin and other microbial products as a component of the "hygiene hypothesis".

In the absence of consistent evidence of benefit from domestic aeroallergen avoidance it is not possible to recommend it as a strategy for preventing childhood asthma.

3.1.2 FOOD ALLERGEN AVOIDANCE

Sensitisation to foods, particularly eggs, frequently precedes the development of aeroallergy and subsequent asthma.¹³⁵ Food allergen avoidance in pregnancy and postnatally has not been shown to prevent the later development of asthma.¹³⁶ Allergen avoidance during pregnancy may adversely affect maternal, and perhaps fetal, nutrition.¹³⁷ High-dose food allergen exposure during pregnancy may reduce subsequent sensitisation rates by inducing tolerance.¹³⁸ 1+

B In the absence of any evidence of benefit and given the potential for adverse effects, maternal food allergen avoidance during pregnancy and lactation is not recommended as a strategy for preventing childhood asthma.

3.1.3 BREAST FEEDING

A systematic review of observational studies on the allergy preventive effects of breast feeding indicates that it is effective for all infants irrespective of allergic heredity. The preventive effect is more pronounced in high-risk infants provided they are breast fed for at least four months.¹³⁹ However, not all studies have demonstrated benefit and in a large birth cohort there was no protective effect against atopy and asthma and maybe even an increase in risk.¹⁴⁰ 2+

Observational studies have the potential to be confounded by, for example, higher rates of breast feeding in atopic families, and taking this into account, the weight of evidence is in favour of breast feeding as a preventive strategy.

C Breast feeding should be encouraged for its many benefits, and as it may also have a potential protective effect in relation to early asthma.

3.1.4 MODIFIED INFANT MILK FORMULAE

Trials of modified milk formulae have not included sufficiently long follow up to establish whether there is any impact on asthma. A Cochrane review identified inconsistencies in findings and methodological concerns amongst studies, which mean that hydrolysed formulae cannot currently be recommended as part of an asthma prevention strategy.¹⁴¹ A review of the use of soy formulae found no significant effect on asthma or any other allergic disease.¹⁴² 1+

In the absence of any evidence of benefit from the use of modified infant milk formulae it is not possible to recommend it as a strategy for preventing childhood asthma.

3.1.5 WEANING

There are conflicting data on the association between early introduction of allergenic foods into the infant diet and the subsequent development of allergy and atopic eczema. No evidence was identified in relation to asthma.¹⁴³ In one study late introduction of egg was associated with a non-significant increase in pre-school wheezing.¹⁴⁴

In the absence of evidence on outcomes in relation to asthma no recommendations on modified weaning can be made.

3.1.6 NUTRITIONAL SUPPLEMENTATION - FISH OILS

Fish oils have a high level of omega-3 polyunsaturated fatty acids (n-3PUFAs). Western diets have a low intake of n-3 PUFAs with a corresponding increase in intake of n-6 PUFAs. This change has been associated with increasing rates of allergic disease and asthma.¹⁴³ Two randomised controlled studies have investigated early life fish oil dietary supplementation in relation to asthma outcomes in children at high risk of atopic disease (at least one parent or sibling had atopy with or without asthma). In a study, powered only to detect differences in cord blood, maternal dietary fish oil supplementation during pregnancy was associated with reduced cytokine release from allergen stimulated cord blood mononuclear cells. However, effects on clinical outcomes at one year, in relation to atopic eczema, wheeze and cough, were marginal.¹⁴⁵ In a second study, fish oil supplementation commencing in early infancy with or without additional house dust mite avoidance, was associated with a significant reduction in wheeze at 18 months of age. By five years of age fish oil supplementation was not associated with effects on asthma or other atopic diseases.¹⁴⁶

1+

In the absence of any evidence of benefit from the use of fish oil supplementation in pregnancy it is not possible to recommend it as a strategy for preventing childhood asthma.

3.1.7 OTHER NUTRIENTS

A number of observational studies have suggested an increased risk of subsequent asthma following reduced (maternal) intakes of selenium (based on umbilical cord levels),¹⁴⁷ or vitamin E based on maternal pregnancy intake.¹⁴⁸ No intervention studies in relation to selenium or vitamin E have yet been conducted and overall there is insufficient evidence to make any recommendations on maternal dietary supplementation as an asthma prevention strategy.¹⁴³ Observational studies suggest that intervention trials are warranted.

3.1.8 MICROBIAL EXPOSURE

The “hygiene hypothesis” suggested that early exposure to microbial products would switch off allergic responses thereby preventing allergic diseases such as asthma. The hypothesis is supported by some epidemiological studies comparing large populations who have or have not had such exposure.^{149,150}

The concept is sometimes described as “the microbial exposure hypothesis”. A double blind placebo controlled trial of the probiotic lactobacillus GG given to mothers resulted in a reduced incidence of atopic eczema in their children but had no effect on IgE antibody or allergic skin test responses. The small sample size and short follow up in this study limit its interpretation.¹⁵¹ Other trials of a range of probiotics and prebiotics are now in progress. There remains insufficient understanding of the ecology of gut flora in infancy in relation to outcomes. Bifido-bacteria may be more important than lactobacilli in reducing susceptibility to allergic disease.¹⁵²

There is insufficient evidence to indicate that the use of dietary probiotics in pregnancy reduces the incidence of childhood asthma.

This is a key area for further work with longer follow up to establish outcomes in relation to asthma.

3.1.9 AVOIDANCE OF TOBACCO SMOKE AND OTHER AIR POLLUTANTS

No evidence has been found to support a link between exposure to environmental tobacco smoke (ETS) or other air pollutants and the induction of allergy.

There is an increased risk of infant wheezing associated with maternal smoking during pregnancy which adversely affects infant lung function.¹⁵³⁻¹⁵⁶ Evidence suggests that early life ETS exposure is associated with later persistent asthma^{157,158} with a strong interaction with genetic polymorphisms which affect antioxidant activity.¹⁵⁹

2+

B

Parents and parents-to-be should be advised of the many adverse effects which smoking has on their children including increased wheezing in infancy and increased risk of persistent asthma.

The limited data on antenatal or early life exposure to other pollutants suggest similar effects to those for ETS, namely increased infant wheezing, enhanced by additional ETS exposure and antioxidant gene variations.¹⁶⁰⁻¹⁶² There is one small study suggesting that vitamin C supplementation will modify the combined effects of genetic polymorphisms and pollution on lung function in children with asthma.¹⁶³ Further research is required before recommendations for practice can be made.

3
4

3.1.10 IMMUNOTHERAPY

Three observational studies with contemporaneous untreated controls in over 8,000 patients have shown that allergen immunotherapy in individuals with a single allergy reduces the numbers subsequently developing new allergic sensitisation over a three to four year follow up.¹⁶⁴⁻¹⁶⁶ One trial compared pollen allergen immunotherapy in children with allergic rhinitis with contemporaneous untreated controls and showed a lower rate of onset of asthma during three years of treatment.¹⁶⁷ This effect was sustained for two years after stopping the therapy.¹⁶⁸ More studies are required to establish whether immunotherapy might have a role in primary prophylaxis.

3.1.11 IMMUNISATION

In keeping with the “microbial exposure hypothesis” some studies have suggested an association between tuberculin responsiveness and subsequent reduced prevalence of allergy, implying a protective effect of BCG. At present, it is not possible to disentangle whether poor tuberculin responsiveness represents an underlying defect which increases the risk of allergy and asthma or whether the immunisation itself has a protective effect.¹⁶⁹

2+

Investigation of the effects of any other childhood immunisation suggests that at worst there is no influence on subsequent allergic disease and maybe some protective effect against the development of asthma.¹⁷⁰

C

All childhood immunisations should proceed normally as there is no evidence of an adverse effect on the incidence of asthma.

3.2 SECONDARY NON-PHARMACOLOGICAL PROPHYLAXIS

3.2.1 HOUSE DUST MITE AVOIDANCE

Increased allergen exposure in sensitised individuals is associated with an increase in asthma symptoms, bronchial hyper-responsiveness and deterioration in lung function.^{127,171,172} However, evidence that reducing allergen exposure can reduce morbidity and/or mortality in asthma is tenuous. In uncontrolled studies, children and adults have derived benefit from removal to a low allergen environment such as occurs at high altitude, although the benefits seen are not necessarily attributable to allergen avoidance alone.¹⁷³

Cochrane reviews on house dust mite control measures in a normal domestic environment have concluded that chemical and physical methods aimed at reducing exposure to house dust mite allergens cannot be recommended.¹⁷⁴ Subsequent studies involving large numbers of patients tend to support this conclusion.^{175,176} Heterogeneity between studies with regard to the intervention and monitoring of outcomes makes interpretation of the systematic review difficult.

1++

Studies of mattress barrier systems have suggested that benefits in relation to treatment requirements for asthma and lung function can occur.^{177,178} Larger and more carefully conducted controlled studies employing combinations of house dust mite reduction strategies are required. At present house dust mite control measures do not appear to be a cost-effective method of achieving benefit, although it is recognised that many families are very committed to attempts to reduce exposure to triggers.

2+

Measures to decrease house dust mites have been shown to reduce numbers of house dust mites, but have not been shown to have an effect on asthma severity.

- ☒ Families with evidence of house dust mite allergy and who wish to try mite avoidance might consider the following:
 - complete barrier bed-covering systems
 - removal of carpets
 - removal of soft toys from bed
 - high temperature washing of bed linen
 - acaricides to soft furnishings
 - good ventilation with or without dehumidification.

3.2.2 OTHER ALLERGENS

Animal allergens, particularly from cat and dog, are potent provokers of asthma symptoms. The reported effects of removal of pets from homes are paradoxical, with either no benefit for asthma^{179,180} or a potential for continued high exposure to induce a degree of tolerance.¹⁸¹ In homes where there is no cat but still detectable cat allergen, there may be a benefit from introducing additional avoidance measures such as air filters and high efficiency vacuum cleaners for cat allergic patients.^{182,183}

Although fungal exposure has been strongly associated with hospitalisation and increased mortality in asthma, no controlled trials have addressed the efficacy of reduction of fungal exposure in relation to control of asthma. Cockroach allergy is not a common problem in the UK and studies of attempts to avoid this allergen elsewhere have produced conflicting results.¹⁸⁴

Studies of individual aeroallergen avoidance strategies show that single interventions have limited or no benefit. A multi faceted approach is more likely to be effective if it addresses all the indoor asthma triggers. Such approaches may even be cost effective.¹⁸⁵ A strategy with a potential impact on mites, mould allergens and indoor pollutants is the use of a mechanical ventilation system to reduce humidity and increase indoor air exchange. The only trial that has assessed this in a controlled fashion failed to demonstrate any significant effects, but the numbers involved were small.¹²⁰ A systematic review of this topic concluded that more research is required.¹⁸⁶

3.3 OTHER ENVIRONMENTAL FACTORS

3.3.1 SMOKING

Direct or passive exposure to cigarette smoke adversely affects quality of life, lung function, need for rescue medications for acute episodes of asthma and long term control with inhaled steroids.¹⁸⁷⁻¹⁹⁰

There are very few trials which have assessed smoking cessation in relation to asthma control. Two studies have demonstrated decreases in childhood asthma severity when parents were able to stop smoking.^{191,192} One study in adults with asthma suggested that smoking cessation improved asthma-specific quality of life, symptoms and drug requirements.¹⁹³ Intervention to reduce smoking has had disappointing outcomes.^{194,195} It is likely that more intensive intervention will be required to achieve meaningful outcomes.¹⁹⁶

Uptake of smoking in teenagers increases the risks of persisting asthma. One study showed a doubling of risk for the development of asthma over six years in 14 year old children who started to smoke¹⁹⁷ (see section 4.2.4 for effect of smoking on treatment).

- C** Parents with asthma should be advised about the dangers of smoking to themselves and their children with asthma and offered appropriate support to stop smoking.

3.3.2 AIR POLLUTION

Challenge studies demonstrate that various pollutants can enhance the response of patients with asthma to allergen inhalation.^{198,199} Time-series studies suggest that air pollution may provoke acute asthma attacks or aggravate existing chronic asthma although the effects are very much less than those with infection or allergen exposure.^{200,201} While it might seem likely that moving from a highly polluted environment might help, in the UK, asthma is more prevalent in 12-14 year olds in non-metropolitan rather than metropolitan areas.²⁰² Much less attention has been focused on indoor pollutants in relation to asthma and more work is required.^{203,204}

3.3.3 IMMUNOTHERAPY

Subcutaneous immunotherapy

Trials of allergen specific immunotherapy by subcutaneous injection of increasing doses of allergen extracts have consistently demonstrated beneficial effects compared with placebo in the management of allergic asthma. Allergens included house dust mite, grass pollen, tree pollen, cat and dog allergen and moulds. Cochrane reviews have concluded that immunotherapy reduces asthma symptoms, the use of asthma medications and improves bronchial hyper-reactivity. The most recent review included 36 trials with house dust mite, 20 with pollen, 10 with animal allergens, two with cladosporium mould, one with latex and six with multiple allergens.²⁰⁵ 1++

Evidence comparing the roles of immunotherapy and pharmacotherapy in the management of asthma is lacking. One study directly compared allergen immunotherapy with inhaled steroids and found that symptoms and lung function improved more rapidly in the group on inhaled steroids.²⁰⁶ Further comparative studies are required. 2+

Immunotherapy for allergic rhinitis has been shown to have a carry over effect after therapy has stopped.²⁰⁷ 3

B Immunotherapy can be considered in patients with asthma where a clinically significant allergen cannot be avoided. The potential for severe allergic reactions to the therapy must be fully discussed with patients.

Sublingual immunotherapy

There has been increasing interest in the use of sublingual immunotherapy, which is associated with far fewer adverse reactions than subcutaneous immunotherapy. A systematic review suggested there were some benefits for asthma control but the magnitude of the effect was small.²⁰⁸ Further randomised controlled trials are required. 1++

B Sublingual immunotherapy cannot currently be recommended for the treatment of asthma in routine practice.

3.4 DIETARY MANIPULATION

3.4.1 ELECTROLYTES

Increasing dietary sodium has been implicated in the geographical variations in asthma mortality²⁰⁹ and high sodium intake is associated with increased bronchial hyper-responsiveness.^{210,211} A systematic review of intervention studies reducing salt intake identified only minimal effects and concluded that dietary salt reduction could not be recommended in the management of asthma.²¹² Low magnesium intakes have been associated with a higher prevalence of asthma with increasing intake resulting in reduced bronchial hyper-responsiveness and higher lung function.²¹³ Magnesium plays a beneficial role in the treatment of asthma through bronchial smooth muscle relaxation, leading to the use of intravenous or inhaled preparations of magnesium sulphate for acute exacerbations of asthma.²¹⁴ Studies of oral supplementation are limited and more trials are required.²¹⁵⁻²¹⁷

3.4.2 FISH OILS/LIPIDS

In vitro studies suggest that supplementing the diet with omega n-3 fatty acids, which are most commonly found in fish oils, might reduce the inflammation associated with asthma.^{218,219} Results from observational studies are inconsistent and a Cochrane review of nine randomised controlled trials concluded that there was insufficient evidence to recommend fish oil supplementation for the treatment of asthma.²²⁰

3.4.3 ANTIOXIDANTS

Observational studies have reported that low vitamin C, vitamin E and selenium intakes are associated with a higher prevalence of asthma.¹⁴³ Intervention studies suggest that neither supplementation with vitamin C, vitamin E or selenium is associated with clinical benefits in people with asthma.²²¹⁻²²³ Observational studies in both adults and children have also consistently shown that a high intake of fresh fruit and vegetable is associated with less asthma and better pulmonary function.²²⁴⁻²³⁰ No intervention studies evaluating the intake of fruit or vegetables and their effects on asthma have been reported.

3.4.4 WEIGHT REDUCTION IN OBESE PATIENTS WITH ASTHMA

Several studies have reported an association between increasing body mass index and symptoms of asthma.²³¹⁻²³⁴ One randomised parallel group study has shown improved asthma control following weight reduction in obese patients with asthma.²³⁵

3
1+

C

Weight reduction is recommended in obese patients with asthma to promote general health and to improve asthma control.

3.4.5 PROBIOTICS

Studies have suggested that an imbalance in gut flora is associated with a higher risk of development of allergy.²³⁶ Trials have investigated the use of probiotics in the treatment of established allergic disease with variable results.^{237,238} Only one study focused on asthma, finding a decrease in eosinophilia but no effect on clinical parameters.²³⁹

1+
2+

In the absence of evidence of benefit, it is not possible to recommend the use of probiotics in the management of asthma.

3.4.6 IMMUNISATIONS

A number of large studies have concluded that high vaccination coverage has no significant impact on any allergic outcome or asthma. There is a suggestion that the higher the vaccine coverage the greater the possibility that there is a degree of protection against the development of allergy in the first years of life.²⁴⁰⁻²⁴³

There is some discussion about whether BCG immunisation may confer protection against allergy and asthma. Research has focused on primary prophylaxis, though there are some studies investigating the use of BCG, with or without allergen, as a means to switch off allergic immune responses. There are some observations suggesting that benefit might occur,²⁴⁴ but results of trials have been disappointing.^{245,246} This is an area that requires further investigation.

There has been concern that influenza vaccination might aggravate respiratory symptoms, though any such effect would be outweighed by the benefits of the vaccination.²⁴⁷ Studies in children have suggested that immunisation with the vaccine does not exacerbate asthma²⁴⁸ but has a small beneficial effect on quality of life in children with asthma.²⁴⁹ The immune response to the immunisation may be adversely affected by high-dose inhaled corticosteroid therapy and this requires further investigation.²⁵⁰ A Cochrane review of pneumococcal vaccine found very limited evidence to support its use specifically in individuals with asthma.²⁵¹

1++

B

Immunisations should be administered independent of any considerations related to asthma. Responses to vaccines may be attenuated by high-dose inhaled steroids.

3.5 COMPLEMENTARY AND ALTERNATIVE MEDICINE

Successive reviews have concluded that the evidence to support any recommendations on complementary or alternative medicine is lacking.²⁵² It is recognised that a lack of evidence does not necessarily mean that treatment is ineffective and high quality research, conducted in the same rigorous and objective fashion as that for conventional therapy, is required.

3.5.1 ACUPUNCTURE

A Cochrane review of 21 trials highlighted many methodological problems with the studies reviewed. Only seven of the trials in 174 patients employed randomisation to active (recognised in traditional Chinese medicine to be of benefit in asthma) or sham acupuncture points (with no recognised activity) for the treatment of persistent or chronic asthma. Blinding was a major problem in the assessment of the results and there were considerable inconsistencies in methodology. The review concluded that there was no evidence for a clinically valuable benefit for acupuncture and no significant benefits in relation to lung function.²⁵³ A later systematic review and meta-analysis of 11 randomised controlled trials found no evidence of an effect in reducing asthma severity but a suggestion that where broncho-constriction was induced to establish efficacy of acupuncture there was a beneficial effect. Concern was expressed about potential preferential publication in favour of positive outcome studies.²⁵⁴ Two other trials of acupuncture in relation to induced asthma were also negative.^{255,256}

1 +

3.5.2 AIR IONISERS

Ionisers have been widely promoted as being of benefit for patients with asthma. A Cochrane review of five studies using negative ion generators and one with a positive ion generator found no evidence of benefit in reducing symptoms in patients with asthma.²⁵⁷ One study demonstrated an increase in night-time cough to a level which approached statistical significance.²⁵⁸

1 ++

1 +

A Air ionisers are not recommended for the treatment of asthma.

3.5.3 BREATHING EXERCISES INCLUDING YOGA AND THE BUTEYKO BREATHING TECHNIQUE

The principle of yoga and Buteyko breathing technique is to control hyperventilation by lowering respiratory frequency. A Cochrane review of breathing exercises found no change in routine measures of lung function.²⁵⁹ One study showed a small reduction in airway responsiveness to histamine utilising pranayama, a form of yoga breathing exercise.²⁶⁰

1 ++

1 +

The Buteyko breathing technique specifically focuses on control of hyperventilation and any ensuing hypocapnia. Four clinical trials suggest benefits in terms of reduced symptoms and bronchodilator usage but no effect on lung function.²⁶¹⁻²⁶⁴

1 +

B Buteyko breathing technique may be considered to help patients to control the symptoms of asthma.

3.5.4 HERBAL AND TRADITIONAL CHINESE MEDICINE

A Cochrane review identified 17 trials, nine of which reported some improvement in lung function but it was not clear that the results would be generalisable.²⁶⁵ A more recent double blind placebo controlled trial of a Chinese herb decoction (Ding Chuan Tang) showed improvement in airway hyper-responsiveness in children with stable asthma.²⁶⁶ It is difficult to disentangle the effects of multiple ingredients; Ding Chuan Tang for example contains nine components. In a second study, 100 children with asthma found that a five-herb mixture gave some benefits in relation to lung function and symptoms compared with placebo.²⁶⁷

1 +

The conclusions of these trials of Chinese herbal therapy are not generalisable due to variations in the herbal mixtures and study designs. There are likely to be pharmacologically active ingredients in the mixtures and further investigations are warranted. There is a need for large appropriately powered placebo controlled studies.

3.5.5 HOMEOPATHY

A Cochrane review identified only three methodologically sound randomised controlled trials, two of which reported some positive effects. A criticism of the studies was that they did not employ individualised homeopathy, which is the essence of this approach to treatment.²⁶⁸ A more recent trial of individualised homeopathy in childhood asthma, which was placebo controlled and appropriately powered, failed to show any evidence of benefit over conventional treatment in primary care.²⁶⁹

1++
1+

3.5.6 HYPNOSIS AND RELAXATION THERAPIES

A systematic review of relaxation therapies, including hypnotherapy, identified five controlled trials, two of which showed some benefits. Overall the methodology of the studies was poor and the review concluded that there was a lack of evidence of efficacy but that muscle relaxation could conceivably benefit lung function in patients with asthma.²⁷⁰

1++

3.6 OTHER COMPLEMENTARY OR ALTERNATIVE APPROACHES

3.6.1 MANUAL THERAPY INCLUDING MASSAGE AND SPINAL MANIPULATION

A Cochrane review identified four relevant RCTs.²⁷¹ The two trials of chiropractic suggest that there is no place for this modality of treatment in the management of asthma. No conclusions can be drawn on massage therapy.

3.6.2 PHYSICAL EXERCISE TRAINING

A Cochrane review²⁵⁹ has shown no effect of physical training on PEF, FEV₁, FVC or VEmax. However, oxygen consumption, maximum heart rate, and work capacity all increased significantly. Most studies discussed the potential problems of exercise induced asthma, but none made any observations on this phenomenon. As physical training improves indices of cardiopulmonary efficiency, it should be seen as part of a general approach to improving lifestyle and rehabilitation in asthma, with appropriate precautions advised about exercise induced asthma (see section 4.7.2).

3.6.3 FAMILY THERAPY

A Cochrane review identified two trials, in 55 children, showing that family therapy may be a useful adjunct to medication in children with asthma.²⁷² Small study size limits the recommendations.



In difficult childhood asthma, there may be a role for family therapy as an adjunct to pharmacotherapy.

Revised
2009

4

Pharmacological management

The aim of asthma management is control of the disease. Control of asthma is defined as:

- no daytime symptoms
- no night-time awakening due to asthma
- no need for rescue medication
- no exacerbations
- no limitations on activity including exercise
- normal lung function (in practical terms FEV_1 and/or $PEF > 80\%$ predicted or best) with minimal side effects.

In clinical practice patients may have different goals and may wish to balance the aims of asthma management against the potential side effects or inconvenience of taking medication necessary to achieve perfect control.

- ☒ Lung function measurements cannot be reliably used to guide asthma management in children under five years of age.

A stepwise approach aims to abolish symptoms as soon as possible and to optimise peak flow by starting treatment at the level most likely to achieve this. Patients should start treatment at the step most appropriate to the initial severity of their asthma. The aim is to achieve early control and to maintain by stepping up treatment as necessary and stepping down when control is good (see figures 4, 5 and 6 for summaries of stepwise management in adults and children).

- ☒ Before initiating a new drug therapy practitioners should check compliance with existing therapies (see section 9.2), inhaler technique (see section 5) and eliminate trigger factors (see section 3).

2009

Until May 2009 all doses of inhaled steroids in this section have been referenced against beclometasone (BDP) given via CFC-MDIs (metered dose inhaler). As BDP CFC is phased out, the reference inhaled steroid will be the BDP-HFA equivalent, which can be used at the same dosage. Adjustments to doses will have to be made for other devices and other corticosteroid molecules (see section 4.2).

In this and the following section, each recommendation has been graded and the supporting evidence assessed for adults (> 12 years old), children 5-12 years, and children under 5 years. The evidence is less clear in children under two and the threshold for seeking an expert opinion should be lowest in these children.

1

2

3

1 Adults**2 Children aged 5-12 years****3 Children under 5 years**

Recommendation does not apply to this age group.

4.1 STEP 1: MILD INTERMITTENT ASTHMA

The following medicines act as short-acting bronchodilators:

inhaled short-acting β_2 agonists²⁷³

inhaled ipratropium bromide²⁷⁴

β_2 agonist tablets or syrup²⁷³

theophyllines.²⁷³

Short-acting inhaled β_2 agonists work more quickly and/or with fewer side effects than the alternatives.²⁷³

>12 years	5-12 years	<5 years
1++	1+	4
1+	1++	
1++		
1++		

A B C Prescribe an inhaled short-acting β_2 agonist as short term reliever therapy for all patients with symptomatic asthma.

4.1.1 FREQUENCY OF DOSING OF INHALED SHORT-ACTING β_2 AGONISTS

Using short-acting β_2 agonists as required is at least as good as regular (four times daily) administration.^{275,276} Unless individual patients are shown to benefit from regular use of inhaled short-acting β_2 agonists then as required use is recommended.

>12 years	5-12 years	<5 years
1++	1++	1++

Good asthma control is associated with little or no need for short-acting β_2 agonist. Using two or more canisters of β_2 agonists per month or >10-12 puffs per day is a marker of poorly controlled asthma that puts patients at risk of fatal or near-fatal asthma.

- ☒ Patients with a high usage of inhaled short-acting β_2 agonists should have their asthma management reviewed.

4.2 STEP 2: INTRODUCTION OF REGULAR PREVENTER THERAPY

For steps 2, 3, and 4, treatments have been judged on their ability to improve symptoms, improve lung function, and prevent exacerbations, with an acceptable safety profile. Improvement of quality of life, while important, is the subject of too few studies to be used to make recommendations at present.

4.2.1 COMPARISON OF INHALED STEROIDS

Many studies comparing different inhaled steroids are of inadequate design and have been omitted from further assessment. In view of the clear differences between normal volunteers and asthma patients in the absorption of inhaled steroids, data from normal volunteers have not been taken into account. Only studies in which more than one dose of at least one of the inhaled steroids or both safety and efficacy had been studied together in the same trial were evaluated. Non-blinded studies also had to be considered because of the problems of obtaining competitors' delivery devices. A series of Cochrane reviews comparing different inhaled steroids using a different methodology have come to the same conclusion.

BDP and budesonide are approximately equivalent in clinical practice, although there may be variations with different delivery devices. There is limited evidence from two open studies of less than ideal design that budesonide via the turbobaler is more clinically effective.²⁹⁵ However, at present a 1:1 ratio should be assumed when changing between BDP and budesonide.

Fluticasone provides equal clinical activity to BDP and budesonide at half the dosage. The evidence that it causes fewer side effects at doses with equal clinical effect is limited.

Mometasone appears to provide equal clinical activity to BDP and budesonide at half the dosage.²⁹⁶ The relative safety of mometasone is not fully established.



Table 8b: Equivalent doses of inhaled steroids relative to BDP and current licensed age indications

These dosage equivalents are approximate and will depend on other factors such as inhaler technique.

		UK licence covers		
Steroid	Equivalent dose	> 12 years	5 – 12 years	< 5 years
Beclometasone dipropionate CFC	400 mcg	No longer available		
Beclometasone				
Clenil modulite	400 mcg	✓	✓	✓
Clickhaler		✓	Over age 6	✗
Aerobec Autohaler		✓	✗	✗
Asmabec Clickhaler		✓	Over age 6	✗
Dry powder (Becodisks)		✓	✓	✓
Easyhaler		✓	✗	✗
Pulvinal		✓	Over age 6	✗
Filair		✓	✓	✓
Qvar	200 to 300 mcg	✓	✗	✗
Fostair	200 mcg	Over age 18	✗	✗
Budesonide				
Turbohaler	400 mcg	✓	✓	✗
Metered dose inhaler		✓	✓	Over age 2
Easyhaler		✓	Over age 6	✗
Novolizer		✓	Over age 6	✗
Symbicort		✓	Over age 6	✗
Symbicort (regular and as required dosing)		Over age 18	✗	✗
Fluticasone				
Metered dose inhaler (HFA)	200 mcg	✓	✓	Over age 4
Accuhaler		✓	✓	Over age 4
Seretide HFA		✓	✓	Over age 4
Seretide (Accuhaler)		✓	✓	Over age 4
Mometasone	200 mcg	✓	✗	✗
Ciclesonide	200 to 300 mcg	✓	✗	✗

Ciclesonide is a new inhaled steroid. Evidence from clinical trials suggests that it has less systemic activity and fewer local oropharyngeal side effects than conventional inhaled steroids.²⁹⁷⁻³⁰¹ The clinical benefit of this is not clear as the exact efficacy to safety ratio compared to other inhaled steroids has not been fully established.

Non-CFC beclometasone is available in more than one preparation, and the potency relative to CFC beclometasone is not consistent between these (see section 5.4).

4.2.2 INHALED STEROIDS

Inhaled steroids are the most effective preventer drug for adults and older children for achieving overall treatment goals.²⁷⁸⁻²⁸² There is an increasing body of evidence demonstrating that, at recommended doses, they are also safe and effective in children under five years with asthma.²⁸³⁻²⁸⁶

>12 years	5-12 years	<5 years
1++	1++	1++

Many non-atopic children with recurrent episodes of viral-induced wheezing in children under five years do not go on to have chronic atopic asthma. The majority do not require treatment with regular inhaled steroids (see section 2.1).

A A A Inhaled steroids are the recommended preventer drug for adults and children for achieving overall treatment goals.

Inhaled steroids should be considered for adults, children aged 5-12 and children under the age of five with any of the following features: using inhaled β_2 agonists three times a week or more; symptomatic three times a week or more; or waking one night a week. In addition, inhaled steroids should be considered in adults and children aged 5-12 who have had an exacerbation of asthma requiring oral corticosteroids in the last two years.^{287,288 767-769}

>12 years	5-12 years	<5 years
1+	1+	1+

Inhaled steroids should be considered for patients with any of the following asthma-related features:

B	C		exacerbations of asthma in the last two years
B	B	B	using inhaled β_2 agonists three times a week or more
B	B	B	symptomatic three times a week or more
B	C	☑	waking one night a week.

Starting dose of inhaled steroids

In mild to moderate asthma, starting at very high doses of inhaled steroids and stepping down confers no benefit.²⁸⁹

>12 years	5-12 years	<5 years
1+	1+	

- ☑ Start patients at a dose of inhaled steroids appropriate to the severity of disease.
- ☑ In adults, a reasonable starting dose will usually be 400 mcg BDP per day and in children 200 mcg BDP per day. In children under five years, higher doses may be required if there are problems in obtaining consistent drug delivery.
- ☑ Titrate the dose of inhaled steroid to the lowest dose at which effective control of asthma is maintained.

Frequency of dosing of inhaled steroids

Most current inhaled steroids are slightly more effective when taken twice rather than once daily, but may be used once daily in some patients with milder disease.^{273,279,290,767,770}

>12 years	5-12 years	<5 years
1+	1+	1+

There is little evidence of benefit for dosage frequency more than twice daily.²⁷⁹

A D D Give inhaled steroids initially twice daily, except ciclesonide which is given once daily.

A D D Once a day inhaled steroids at the same total daily dose can be considered if good control is established.

4.2.3 SAFETY OF INHALED STEROIDS

The safety of inhaled steroids is of crucial importance and a balance between benefits and risks for each individual needs to be assessed. Account should be taken of other topical steroid therapy when assessing systemic risk. It has been suggested that steroid warning cards should be issued to patients on higher dose inhaled steroids, but the benefits and possible disadvantages, particularly with regard to compliance, of such a policy remain to be defined.

Adults

There is little evidence that doses below 800 mcg BDP per day cause any short term detrimental effects apart from the local side effects of dysphonia and oral candidiasis. However, the possibility of long term effects on bone has been raised. One systematic review reported no effect on bone density at doses up to 1,000 mcg BDP per day.²⁹¹ The significance of small biochemical changes in adrenocortical function is unknown.

- ☒ Titrate the dose of inhaled steroid to the lowest dose at which effective control of asthma is maintained.

Children

Administration of inhaled steroids at or above 400 mcg BDP a day or equivalent may be associated with systemic side effects.²⁹² These may include growth failure and adrenal suppression. Isolated growth failure is not a reliable indicator of adrenal suppression and monitoring growth cannot be used as a screening test of adrenal function.^{290,293}

Clinical adrenal insufficiency has been identified in a small number of children who have become acutely unwell at the time of intercurrent illness. Most of these children had been treated with high doses of inhaled corticosteroids. The dose or duration of inhaled steroid treatment required to place a child at risk of clinical adrenal insufficiency is unknown but is likely to occur at ≥ 800 mcg BDP per day or equivalent. The low-dose ACTH test is considered to provide a physiological stimulation of adrenal responsiveness but it is not known how useful such a sensitive test is at predicting clinically relevant adrenal insufficiency.^{59,294} In addition, it is unknown how frequently tests of adrenal function would need to be repeated if a child remained on high-dose inhaled corticosteroid. At higher doses, add-on agents, for example, long-acting β_2 agonists, should be actively considered.



While the use of inhaled corticosteroids may be associated with adverse effects (including the potential to reduced bone mineral density) with careful inhaled steroid dose adjustment this risk is likely to be outweighed by their ability to reduce the need for multiple bursts of oral corticosteroids.⁷⁷¹

- ☒ Monitor height of children on high doses of inhaled steroids on a regular basis.
- ☒ The lowest dose of inhaled steroids compatible with maintaining disease control should be used.

For children treated with ≥ 800 mcg BDP per day or equivalent:


- ☒ Specific written advice about steroid replacement (eg Steroid Alert Card) in the event of a severe intercurrent illness or surgery should be part of the management plan.
- ☒ The child should be under the care of a specialist paediatrician for the duration of the treatment.

Consider the possibility of adrenal insufficiency in any child maintained on inhaled steroids presenting with shock or a decreased level of consciousness; serum biochemistry and blood glucose levels should be checked urgently. Consider whether intramuscular (IM) hydrocortisone is required.

4.2.4 SMOKING

Current and previous smoking reduces the effect of inhaled steroids; which may be overcome with increased doses.^{187,302}

Patients should be advised that smoking reduces the effectiveness of therapy.

B  **Clinicians should be aware that higher doses of inhaled steroids may be needed in patients who are smokers or ex-smokers.**

4.2.5 OTHER PREVENTER THERAPIES

Inhaled steroids are the first choice preventer drug. Long-acting inhaled β_2 agonists should not be used without inhaled corticosteroids.³⁰³ Alternative, less effective preventer therapies in patients taking short-acting β_2 agonists alone are:

- Chromones
 - Sodium cromoglicate is of some benefit in adults^{273, 304} and is effective in children aged 5-12³⁰⁵
 - Nedocromil sodium is also of benefit in adults and children >5 ^{306,307}
 - There is no clear evidence of benefit with sodium cromoglicate in children aged <5 ³⁰⁸
- Leukotriene receptor antagonists have some beneficial clinical effect^{279,309,310}
- Theophyllines have some beneficial effect^{273,278}
- Antihistamines and ketotifen are ineffective.³¹¹

>12 years	5-12 years	<5 years
1+	1+	
1++	1+	
1++	1++	1++
1+	1+	1+
1++	1++	1++

☒ In children under five years who are unable to take inhaled corticosteroids, leukotriene receptor antagonists are an effective first line preventor.

4.3 STEP 3: INITIAL ADD-ON THERAPY

A proportion of patients with asthma may not be adequately controlled at step 2. Before initiating a new drug therapy practitioners should recheck compliance, inhaler technique and eliminate trigger factors. The duration of a trial of add-on therapy will depend on the desired outcome. For instance, preventing nocturnal awakening may require a relatively short trial of treatment (days or weeks), whereas preventing exacerbations of asthma or decreasing steroid tablet use may require a longer trial of therapy (weeks or months). If there is no response to treatment the drug should be discontinued.

4.3.1 CRITERIA FOR INTRODUCTION OF ADD-ON THERAPY

No exact dose of inhaled steroid can be deemed the correct dose at which to add another therapy. The addition of other treatment options to inhaled steroids has been investigated at doses from 200-1,000 mcg BDP in adults and up to 400 mcg BDP in children.³¹²⁻³¹⁵ Many patients will benefit more from add-on therapy than from increasing inhaled steroids above doses as low as 200 mcg BDP/day. At doses of inhaled steroid above 800 mcg BDP/day side effects become more frequent. An absolute threshold for introduction of add-on therapy in all patients cannot be defined.

>12 years	5-12 years	<5 years
1+	1+	

4.3.2 ADD-ON THERAPY

Options for add-on therapy are summarised in Figure 3.

In adult patients taking inhaled steroids at doses of 200-800 mcg BDP/day and in children taking inhaled steroids at a dose of 400 mcg/day the following interventions are of value:

- first choice would be the addition of an inhaled long-acting β_2 agonist (LABA), which improves lung function and symptoms, and decreases exacerbations.^{312,316,317}

>12 years	5-12 years	<5 years
1++	1++	

A	B		<p>The first choice as add-on therapy to inhaled steroids in adults and children (5-12 years) is an inhaled long-acting β_2 agonist, which should be considered before going above a dose of 400 mcg BDP or equivalent per day and certainly before going above 800 mcg BDP.</p>

		B	<p>The first choice as add-on therapy to inhaled steroids in children under five years old is leukotriene receptor antagonists.</p>
--	--	---	--

If, as occasionally happens, there is no response to inhaled long-acting β_2 agonist, stop the LABA and increase the dose of inhaled steroid to 800 mcg BDP/day (*adults*) or 400 mcg BDP/day (*children*) if not already on this dose. If there is a response to LABA, but control remains suboptimal, continue with the LABA and increase the dose of inhaled steroid to 800 mcg/day (*adults*) or 400 mcg/day (*children* 5-12 years).³¹⁸

>12 years	5-12 years	<5 years
4	4	

D	D		<p>If asthma control remains suboptimal after the addition of an inhaled long-acting β_2 agonist then the dose of inhaled steroids should be increased to 800 mcg/day in adults or 400 mcg/day in children (5-12 years), if not already on these doses.</p>

- | >12 years | 5-12 years | <5 years |
|-----------|------------|----------|
| 1++ | 1++ | 1+ |
| 1+ | 1- | |
| 1++ | | |
- **Leukotriene receptor antagonists** may provide improvement in lung function, a decrease in exacerbations, and an improvement in symptoms.^{310,319,320}
 - **Theophyllines** may improve lung function and symptoms, but side effects occur more commonly.³¹³
 - **Slow-release β_2 agonist tablets** may also improve lung function and symptoms, but side effects occur more commonly.³¹²

- ☒ If control remains inadequate after stopping a LABA and increasing the dose of inhaled steroid, consider sequential trials of add-on therapy, ie leukotriene receptor antagonists, theophyllines, slow-release β_2 agonist tablets (*this in adults only*).

Addition of short-acting anticholinergics is generally of no value.^{314,321} Addition of nedocromil is of marginal benefit.^{304,315}

>12 years	5-12 years	<5 years
1+		

2009

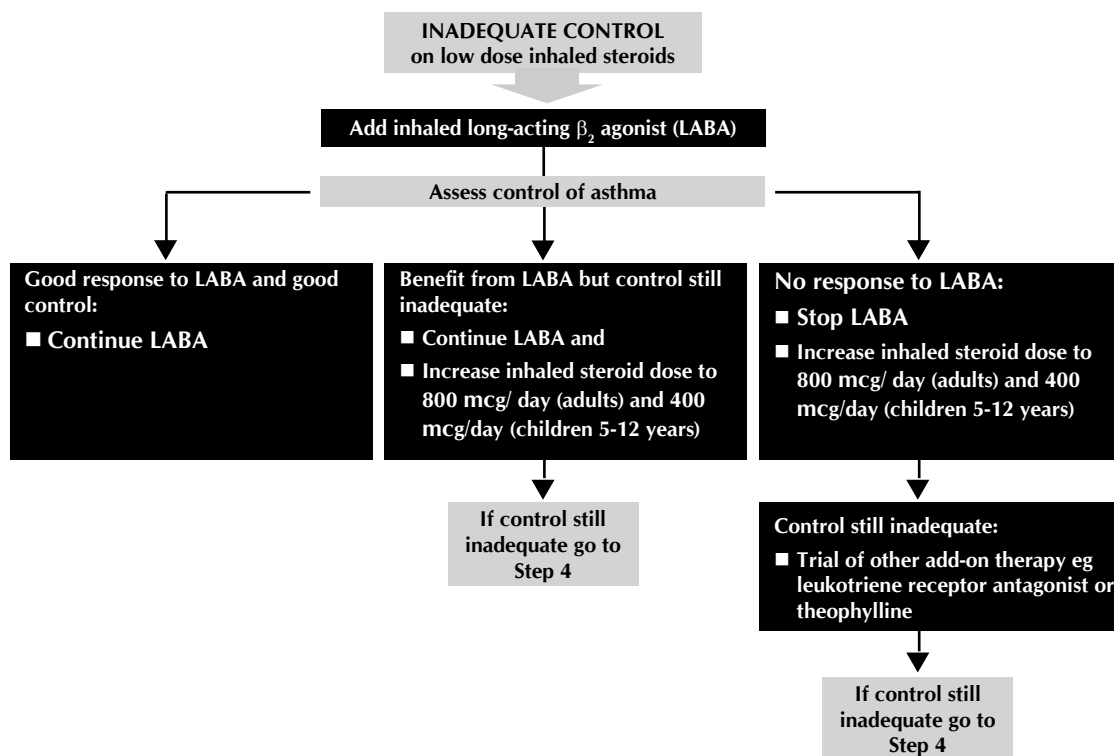
In selected adult patients at step 3 who are poorly controlled or in selected adult patients at step 2 (above BDP 400 mcg/day who are poorly controlled), the use of budesonide/formoterol in a single inhaler as rescue medication instead of a short-acting β_2 agonist, in addition to its regular use as controller therapy has been shown to be an effective treatment regimen.³²³⁻³²⁷ When this management option is introduced the total regular dose of daily inhaled corticosteroids should not be decreased. The regular maintenance dose of inhaled steroids may be budesonide 200 mcg twice daily or budesonide 400 mcg twice daily. Patients taking rescue budesonide/formoterol once a day or more should have their treatment reviewed. Careful education of patients about the specific issues around this management strategy is required.

In patients on inhaled steroids whose asthma is stable, no intervention has been consistently shown to decrease inhaled steroid requirement in a clinically significant manner compared to placebo.

The Medicines and Healthcare products Regulatory Agency (MHRA) has completed a full review of the balance of risks and benefits associated with long-acting β_2 agonists in the management of asthma and chronic obstructive pulmonary disease.³²² They have concluded that long-acting β_2 agonists can continue to be used in the management of asthma provided they are used with inhaled corticosteroids. This issue has been reviewed by the guideline development group, which came to the same conclusion.

- ☒ Long-acting inhaled β_2 agonists should only be started in patients who are already on inhaled corticosteroids.

Figure 3: Summary of step 3: Add-on therapy



4.3.3 COMBINATION INHALERS

There is no difference in efficacy in giving inhaled steroid and long-acting β_2 agonist in combination or in separate inhalers.³¹⁸

>12 years	5-12 years	<5 years
1++	1++	

Once a patient is on stable therapy, combination inhalers have the advantage of guaranteeing that the long-acting β_2 agonist is not taken without inhaled steroid.

4.4 STEP 4: POOR CONTROL ON MODERATE DOSE OF INHALED STEROID + ADD-ON THERAPY: ADDITION OF FOURTH DRUG

In a small proportion of patients asthma is not adequately controlled on a combination of short-acting β_2 agonist as required, inhaled steroid (800 mcg BDP daily), and an additional drug, usually a long-acting β_2 agonist. There are very few clinical trials in this specific patient group to guide management. The following recommendations are largely based on extrapolation from trials of add-on therapy to inhaled steroids alone.

D	D	
		<p>If control remains inadequate on 800 mcg BDP daily (adults) and 400 mcg daily (children) of an inhaled steroid plus a long-acting β_2 agonist, consider the following interventions:</p> <ul style="list-style-type: none"> ▪ increasing inhaled steroids to 2000 mcg BDP/day (adults) or 800 mcg BDP/day (children 5-12 years) * ▪ leukotriene receptor antagonists ▪ theophyllines ▪ slow release β_2 agonist tablets, though caution needs to be used in patients already on long-acting β_2 agonists.

* at high doses of inhaled steroid via MDI, a spacer should be used.

There are no controlled trials indicating which of these is the best option, although the potential for side effects is greater with theophyllines and β_2 agonist tablets.

- ☒ If a trial of an add-on treatment is ineffective, stop the drug (or in the case of increased dose of inhaled steroid, reduce to the original dose).
- ☒ Before proceeding to step 5, refer patients with inadequately controlled asthma, especially children, to specialist care.

4.5 STEP 5: CONTINUOUS OR FREQUENT USE OF ORAL STEROIDS

- ☒ For the small number of patients not controlled at step 4, use daily steroid tablets in the lowest dose providing adequate control.

4.5.1 PREVENTION AND TREATMENT OF STEROID TABLET-INDUCED SIDE EFFECTS

Patients on long term steroid tablets (eg longer than three months) or requiring frequent courses of steroid tablets (eg three to four per year) will be at risk of systemic side effects.⁵⁹

- blood pressure should be monitored
- urine or blood sugar and cholesterol should be checked. Diabetes mellitus and hyperlipidaemia may occur
- bone mineral density should be monitored. When a significant reduction occurs, treatment with a long-acting bisphosphonate should be offered (see British Osteoporosis Society guidelines, www.nos.org.uk)³²⁸
- growth (height and weight) should be monitored in children
- cataracts may be screened for in children through community optometric services.

4.5.2 STEROID TABLET-SPARING MEDICATION

The aim of treatment is to control the asthma using the lowest possible dose or, if possible, to stop long term steroid tablets completely.

Inhaled steroids are the most effective drug for decreasing requirement for long term steroid tablets.^{280,281}

>12 years	5-12 years	<5 years
1++	4	

There is limited evidence for the ability of long-acting β_2 agonists, theophyllines, or leukotriene receptor antagonists to decrease requirement for steroid tablets, but they may improve symptoms and pulmonary function.³²⁹

A	D		<p>In adults, the recommended method of eliminating or reducing the dose of steroid tablets is inhaled steroids, at doses of up to 2,000 mcg/day, if required.</p> <p>In children aged 5-12, consider very carefully before going above an inhaled steroid dose of 800 mcg/day.</p>
D	D	D	<p>There is a role for a trial of treatment with long acting β_2 agonists, leukotriene receptor antagonists, and theophyllines for about six weeks. They should be stopped if no improvement in steroid dose, symptoms or lung function is detected.</p>

Immunosuppressants (methotrexate, ciclosporin and oral gold) decrease long term steroid tablet requirements, but all have significant side effects. There is no evidence of persisting beneficial effect after stopping them; and there is marked variability in response.³³⁰

>12 years	5-12 years	<5 years
1++	3	

- ☒ Immunosuppressants (methotrexate, ciclosporin and oral gold) may be given as a three month trial, once other drug treatments have proved unsuccessful. Their risks and benefits should be discussed with the patient and their treatment effects carefully monitored. Treatment should be in a centre with experience of using these medicines.

	>12 years 1+	5-12 years	<5 years
Colchicine and intravenous immunoglobulin have not been shown to have any beneficial effect in adults. ³³⁰			
Continuous subcutaneous terbutaline infusion has been reported to be beneficial in severe asthma but efficacy and safety have not been assessed in RCTs. ^{331,332,772,773}	4	3	3
Anti-TNF alpha therapy has been investigated in severe asthma ^{333,334} but these studies are too small and too short term to allow recommendation of anti-TNF therapy outside the context of a controlled clinical trial.			

4.5.3 ANTI-IGE MONOCLONAL ANTIBODY

Omalizumab is a humanised monoclonal antibody which binds to circulating IgE, markedly reducing levels of free serum IgE.^{774,775} In adults and children over 12, it is licensed in the UK with the following indication; patients on high-dose inhaled steroids and long-acting β_2 agonists who have impaired lung function are symptomatic with frequent exacerbations, and have allergy as an important cause of their asthma. Omalizumab is given as a subcutaneous injection every two to four weeks depending on dose. The total IgE must be less than 700 iu/litre for it to be effective.

In the single study in the licensed group, there was a 19% reduction in exacerbations of asthma requiring oral steroids which was non-significant. When corrected for imbalance in the exacerbation history at baseline, there was a 26% reduction in severe exacerbations (0.91 on placebo vs 0.68 on omalizumab over a 28 week period, $p=0.042$). This was associated with a 2.8% increase in FEV₁, a non-significant 0.5 puffs/day decrease in β_2 agonist use and 13% more patients having a significant improvement in health related quality of life. At IgE levels below 76 iu/l the beneficial effect is reduced.⁷⁷⁶

Local skin reactions may occur. Anaphylaxis, presenting as bronchospasm, hypotension, syncope, urticaria, and/or angioedema of the throat or tongue has been reported to occur after administration of omalizumab. Anaphylaxis has occurred as early as the first dose, but has also occurred after one year. Due to risk of anaphylaxis, omalizumab should only be administered to patients in a healthcare setting under direct medical supervision.

- ☒ Omalizumab treatment should only be initiated in specialist centres with experience of evaluation and management of patients with severe and difficult asthma.

4.5.4 STEROID FORMULATIONS

Prednisolone is the most widely used steroid tablet for maintenance therapy in chronic asthma. There is no evidence that other formulations offer any advantage.

4.5.5 FREQUENCY OF DOSING OF STEROID TABLETS

Although popular in paediatric practice, there are no studies to show whether alternate day steroids produce fewer side effects than daily steroids.

Figure 4: Summary of stepwise management in adults

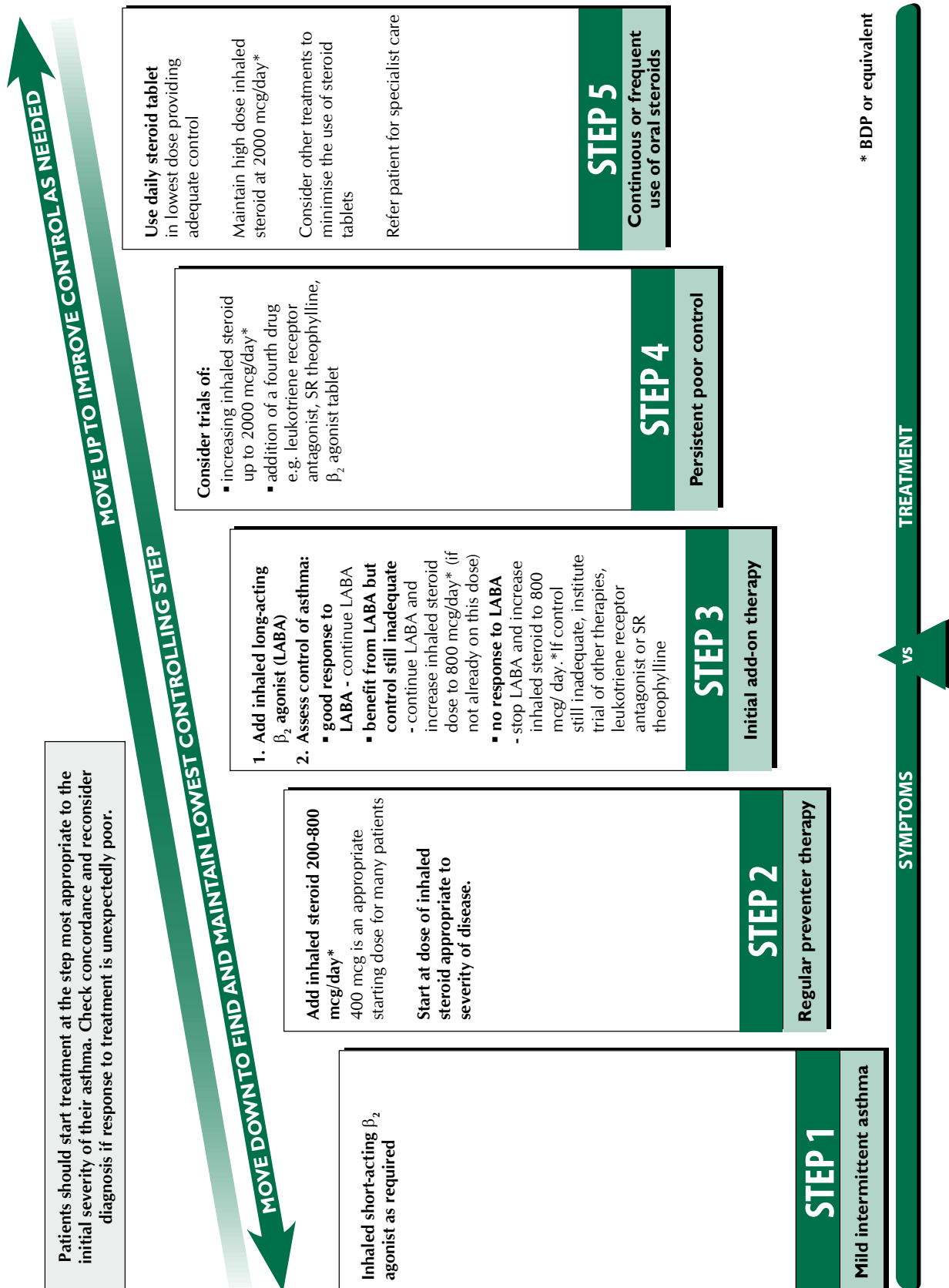


Figure 5: Summary of stepwise management in children aged 5-12 years

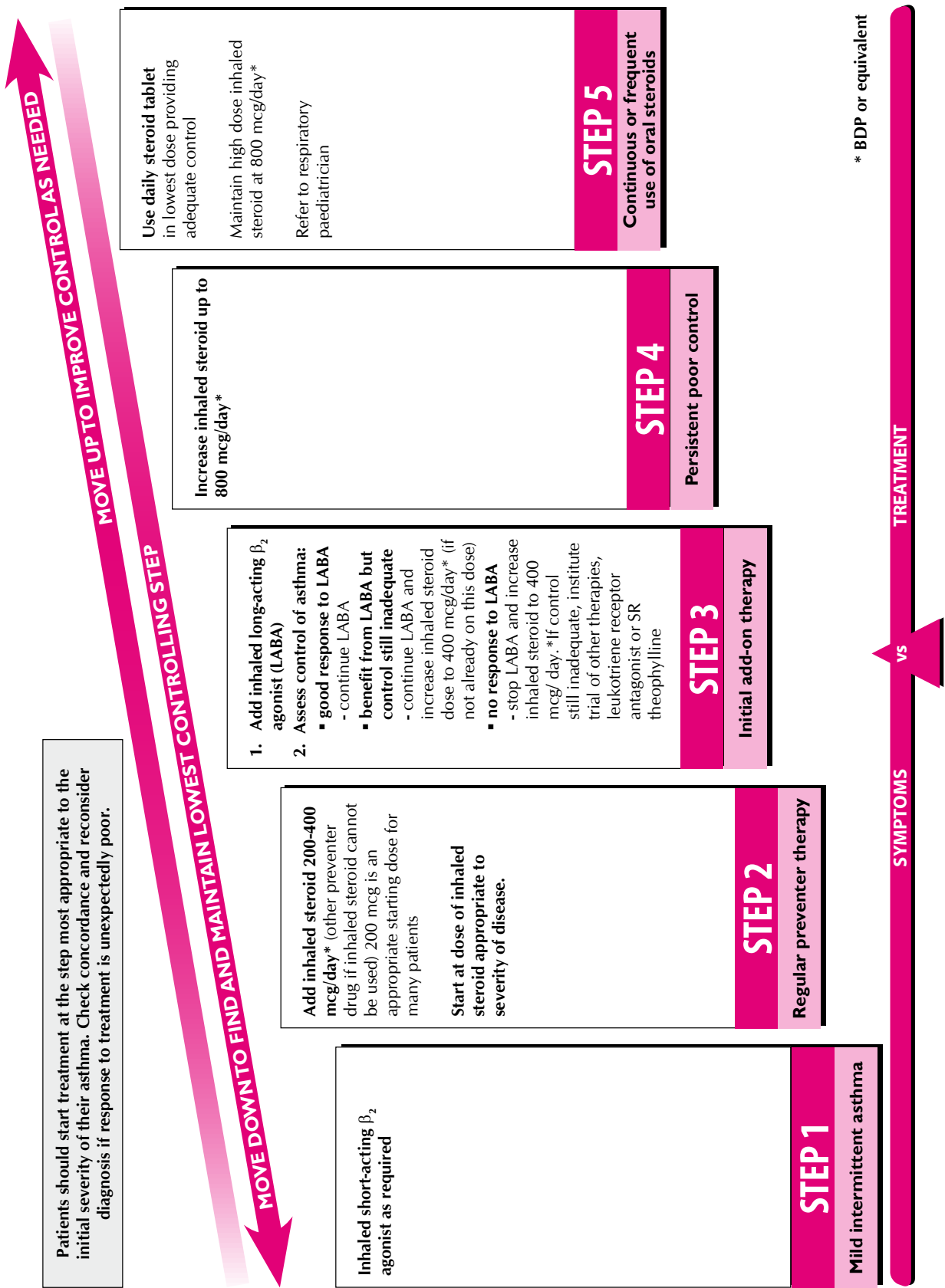
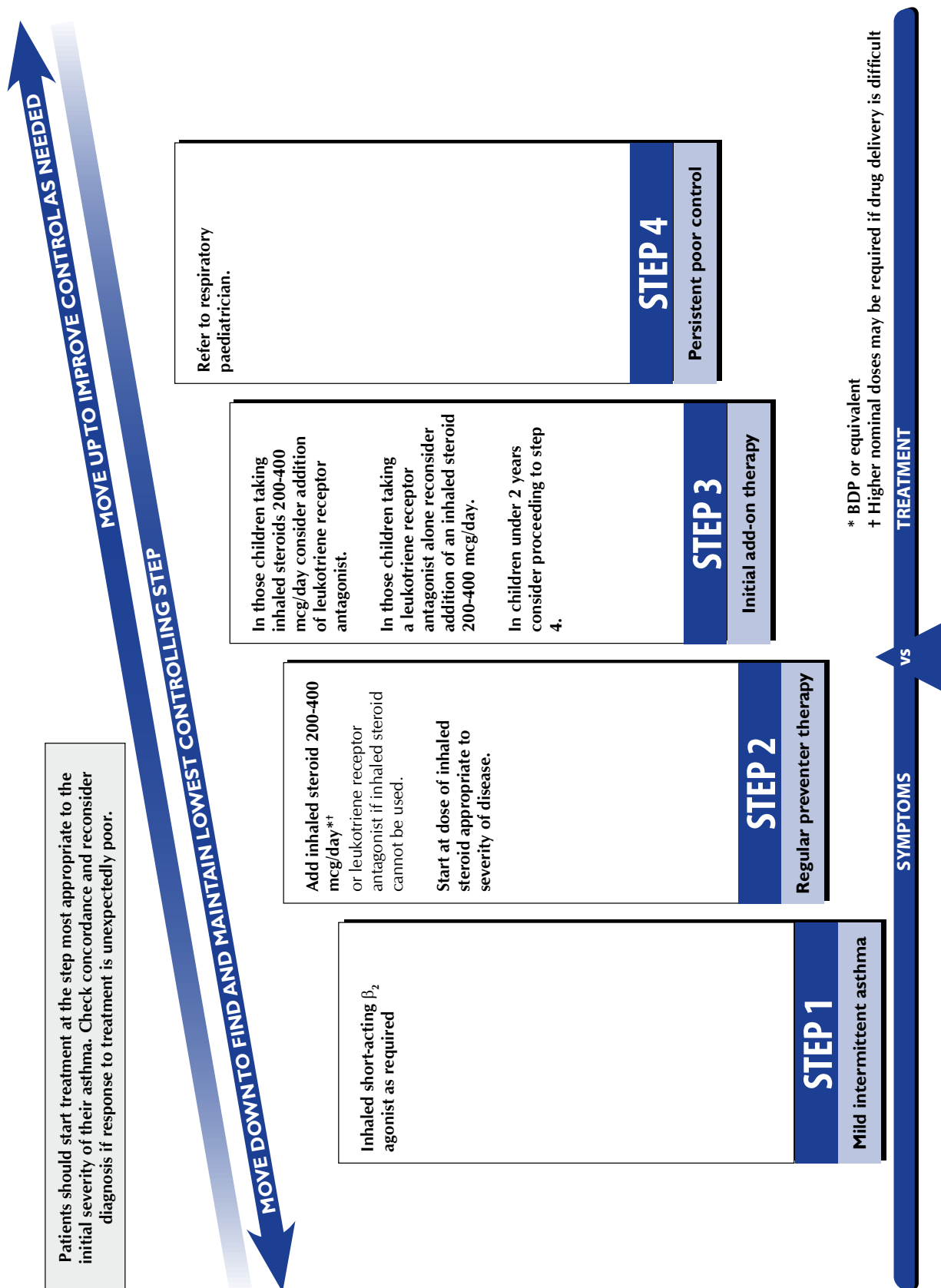


Figure 6: Summary of stepwise management in children less than 5 years



4.6 STEPPING DOWN

Stepping down therapy once asthma is controlled is recommended, but often not implemented leaving some patients over-treated. There are few studies that have investigated the most appropriate way to step down treatment. A study in adults on at least 900 mcg per day of inhaled steroids has shown that for patients who are stable it is reasonable to attempt to halve the dose of inhaled steroids every three months.³³⁴

2009 Some children with milder asthma and a clear seasonal pattern to their symptoms may have a more rapid dose reduction during their 'good' season.

- ☑ Regular review of patients as treatment is stepped down is important. When deciding which drug to step down first and at what rate, the severity of asthma, the side effects of the treatment, time on current dose, the beneficial effect achieved, and the patient's preference should all be taken into account.
- ☑ Patients should be maintained at the lowest possible dose of inhaled steroid. Reduction in inhaled steroid dose should be slow as patients deteriorate at different rates. Reductions should be considered every three months, decreasing the dose by approximately 25-50% each time.

4.7 SPECIFIC MANAGEMENT ISSUES

4.7.1 EXACERBATIONS OF ASTHMA

Although recommended for both adults and children in previous guidelines and as part of asthma action plans, doubling the dose at the time of an exacerbation is of unproven value.³³⁵ In adult patients on a low dose (200 mcg BDP) of inhaled steroids, a fivefold increase in dose at the time of exacerbation leads to a decrease in the severity of exacerbations.^{335,336} This study should not be extrapolated to patients already taking higher doses of inhaled steroids and further evidence in this area is required.

2009 There is some limited evidence that leukotriene antagonists may be used intermittently in children with episodic asthma. Treatment is started at the onset of either asthma symptoms or of coryzal symptoms and continued for seven days.⁷⁷⁷

>12 years	5-12 years	<5 years
	1++	1++

The benefits of parent-initiated oral steroids at the start of an exacerbation has not been proven.⁷⁷⁸

4.7.2 EXERCISE INDUCED ASTHMA

When given chronically the following medicines give protection against exercise induced asthma:

- inhaled steroids^{280, 281,337}
- short-acting β_2 agonists²⁷³
- long-acting β_2 agonists³³⁸
- theophyllines^{329,339}
- leukotriene receptor antagonists³⁴⁰
- chromones³⁴¹
- β_2 agonist tablets.³⁴²

The following medicines do not give protection against exercise induced asthma at normal doses:

- anticholinergics³⁴³
- ketotifen³⁴⁴
- antihistamine.³⁴⁵

Long-acting β_2 agonists and leukotriene antagonists provide more prolonged protection than short-acting β_2 agonists, but a degree of tolerance develops with LABA particularly with respect to duration of action. No tolerance has been demonstrated with leukotriene receptor antagonists.^{338,340,779}

>12 years	5-12 years	<5 years
1++	1++	
1++	1++	
1++	1++	
1-	2+	
1++	2+	
1++	2+	
1++	1+	
1+	1+	
1+	1+	
1++	1++	
>12 years	5-12 years	<5 years
1++	1++	

- ☒ For most patients, exercise induced asthma is an expression of poorly controlled asthma and regular treatment including inhaled steroids should be reviewed.

If exercise is a specific problem in patients taking inhaled steroids who are otherwise well controlled, consider the following therapies:

A	C		▪ leukotriene receptor antagonists
A	A		▪ long-acting β_2 agonists
C	C		▪ chromones
A	A		▪ oral β_2 agonists
C	C		▪ theophyllines.

Immediately prior to exercise, inhaled short-acting β_2 agonists are the drug of choice.²⁷³

A	A		Immediately prior to exercise, inhaled short-acting β_2 agonists are the drug of choice.
---	---	--	--

4.7.3 RHINITIS

Patients with asthma often have rhinitis. The most effective therapy is intranasal steroids.³⁴⁶ Treatment of allergic rhinitis with intranasal steroids has not been shown in double blind placebo-controlled trials to improve asthma control.

>12 years	5-12 years	<5 years
1+		

4.7.4 ALLERGIC BRONCHOPULMONARY ASPERGILLOSIS

In adult patients with allergic bronchopulmonary aspergillosis (ABPA), itraconazole may decrease steroid tablet dose and improve asthma control.^{347,348}

>12 years	5-12 years	<5 years
1+		
2+		

C			In adult patients with ABPA, a four month trial of itraconazole should be considered.
---	--	--	--

- ☒ Careful monitoring for side effects, particularly hepatic, is recommended.

4.7.5 ASPIRIN-INTOLERANT ASTHMA

There are theoretical reasons to suggest that leukotriene receptor antagonists might be of particular value in the treatment of aspirin-intolerant asthma. However, there is little evidence to justify managing patients with aspirin-intolerant asthma in a different manner to other patients with asthma, apart from the rigorous avoidance of non-steroidal anti-inflammatory medications.³⁴⁹

4.7.6 GASTRO-OESOPHOGEAL REFLUX

A Cochrane review of twelve double blind controlled trials found that treatment of gastro-oesophageal reflux had no benefit on asthma symptoms or lung function when both conditions were present. Reduction in dry cough was observed although this was probably not due to improved asthma control.^{350,351}

4.7.7 β -BLOCKERS

β -blockers, including eye drops, are contraindicated in patients with asthma.

5 Inhaler devices

Although studies of inhaler devices are more suitable for an evidence based approach than many other aspects of asthma management, a number of methodological issues complicate evidence review in this area. In young (0-5 years) children, little or no evidence is available on which to base recommendations.

5.1 TECHNIQUE AND TRAINING

Studies of technique and the effects of training have used arbitrary non-standardised scores making comparison difficult. Although technique will have some bearing, it does not necessarily relate to clinical effectiveness.

The proportion of patients making no mistakes with an inhaler in one well conducted study was 23-43% for pMDI, 53-59% for dry powder inhaler (DPI) and 55-57% for pMDI + spacer. When technique was assessed as number of steps correct out of the total number of steps, pMDI + spacer was slightly better than DPI.³⁵²

Teaching technique improved the correct usage score from a mean of 60% to 79%. Figures for no mistakes post-teaching were 63% for pMDI, 65% for DPI, and 75% for breath-actuated MDI (the latter figure based on one study of 2,467 patients).³⁵²

>12 years	5-12 years	<5 years
1++		

B ☒ ☒ **Prescribe inhalers only after patients have received training in the use of the device and have demonstrated satisfactory technique.**

5.2 β_2 AGONIST DELIVERY

5.2.1 ACUTE ASTHMA

pMDI + spacer is at least as good as a nebuliser at treating mild and moderate exacerbations of asthma in children and adults.³⁵³⁻³⁵⁶

>12 years	5-12 years	<5 years
1++	1++	

A **A** **B** **Children and adults with mild and moderate exacerbations of asthma should be treated by pMDI + spacer with doses titrated according to clinical response.**

There are no data to make recommendations in severe (life threatening) asthma.

5.2.2 STABLE ASTHMA

For children aged 0-5, there is no evidence comparing nebuliser and other inhalers and the data are insufficiently extensive or robust to draw conclusions for pMDI vs. DPI.

In children aged 5-12 there is no significant difference between pMDI and DPI. In adults there is no significant difference between pMDI + spacer and DPI. The lower pulse rate with pMDI v Turbohaler is the only difference with regard to side effects. Patients have been shown to prefer Turbohaler to pMDI.^{352,357,358}

>12 years	5-12 years	<5 years
1++	1++	

A **A** **B** **In children aged 5-12, pMDI + spacer is as effective as any other hand held inhaler.**

A **B** **B** **In adults, pMDI ± spacer is as effective as any other hand held inhaler, but patients may prefer some types of DPI.**

There are no data to make recommendations in children under five.

☒ Choice of reliever inhaler for stable asthma should be based on patient preference and assessment of correct use. Many patients will not be prepared to carry a spacer.

5.3 INHALED STEROIDS FOR STABLE ASTHMA

There are no comparative data on inhaled steroids for stable asthma in children under five years. A single study included 4-5 year olds, but the data were not extractable.

For the delivery of inhaled steroids in stable asthma in children aged 5-12 years, pMDI is as effective as Clickhaler,^{359,360} and Pulvinal is as effective as Diskhaler.³⁶¹ No significant clinical difference was found between pMDI and Turbohaler at half the dose for the same drug (budesonide).^{352,362} This comparison cannot necessarily be made against other inhaled steroid /device combinations.

In adults, there is no clinical difference in effectiveness of pMDI ± spacer v DPI. Breath-actuated MDI is as effective as pMDI. More recent DPIs are as effective as older DPIs.³⁰⁵ Nebulisers have not been shown to be superior to pMDI + spacer for delivery of inhaled steroids in chronic asthma. A specialised specific nebuliser may provide improved lung function and reduced rescue therapy use, but at high prescribed doses. Higher doses (> 2 mg) are generally only licensed for use from a nebuliser.^{352,362}

>12 years	5-12 years	<5 years
1++	1++	



In children aged 5-12 years, pMDI + spacer is as effective as any DPI.



In adults, a pMDI ± spacer is as effective as any DPI.

No recommendation can be given for nebulised therapy in children aged 5-12 years and there is no evidence relating to children aged < 5 years.

5.4 CFC PROPELLANT PMDI VS HFA PROPELLANT PMDI

HFA pMDI salbutamol is as effective as CFC pMDI salbutamol at standard therapeutic doses.^{359,363-368}

>12 years	5-12 years	<5 years
1++		

It is important to differentiate Qvar from other HFA beclametasone products. Many studies now show Qvar equivalence at half the dose of CFC BDP pMDI, whereas non-Qvar HFA BDP pMDI studies show equivalence at 1:1 dosing.^{360,369-375}

HFA fluticasone is as effective as CFC fluticasone across the standard clinical dose range.³⁷⁶⁻³⁸⁰

>12 years	5-12 years	<5 years
1++		



Salbutamol HFA can be substituted for salbutamol CFC at 1:1 dosing.



HFA BDP pMDI (Qvar) may be substituted for CFC BDP pMDI at 1:2 dosing. This ratio does not apply to reformulated HFA BDP pMDIs.



Fluticasone HFA can be substituted for fluticasone CFC at 1:1 dosing.

5.5 PRESCRIBING DEVICES

There is no evidence to dictate an order in which devices should be tested for those patients who cannot use pMDI. In the absence of evidence, the most important points to consider are patient preference and local cost.

- ☒
 - The choice of device may be determined by the choice of drug.
 - If the patient is unable to use a device satisfactorily an alternative should be found.
 - The patient should have their ability to use an inhaler device assessed by a competent healthcare professional (*see section 5.1*).
 - The medication needs to be titrated against clinical response to ensure optimum efficacy.
 - Reassess inhaler technique as part of structured clinical review (*see section 8.1.2*).
- ☒

In children aged 0-5 years, pMDI and spacer are the preferred method of delivery of β_2 agonists or inhaled steroids. A face mask is required until the child can breathe reproducibly using the spacer mouthpiece. Where this is ineffective a nebuliser may be required.

5.6 USE AND CARE OF SPACERS

- ☒
 - The spacer should be compatible with the pMDI being used.
 - The drug should be administered by repeated single actuations of the metered dose inhaler into the spacer, each followed by inhalation.
 - There should be minimal delay between pMDI actuation and inhalation.
 - Tidal breathing is as effective as single breaths.
 - Spacers should be cleaned monthly rather than weekly as per manufacturer's recommendations or performance is adversely affected. They should be washed in detergent and allowed to dry in air. The mouthpiece should be wiped clean of detergent before use.
 - Drug delivery may vary significantly due to static charge. Metal and other antistatic spacers are not affected in this way.
 - Plastic spacers should be replaced at least every 12 months but some may need changing at six months.

Revised
2009

6 Management of acute asthma

6.1 LESSONS FROM STUDIES OF ASTHMA DEATHS AND NEAR-FATAL ASTHMA

Confidential enquires into over 200 asthma deaths in the UK conclude there are factors associated with the disease, the medical management and the patient's behaviour or psychosocial status which contribute to death. Most deaths occurred before admission to hospital.³⁸¹⁻³⁸⁵

6.1.1 DISEASE FACTORS

Most patients who died of asthma had chronically severe asthma. In a minority the fatal attack occurred suddenly in a patient with mild or moderately severe background disease.³⁸¹⁻³⁸⁶ 2++

6.1.2 MEDICAL MANAGEMENT

Many of the deaths occurred in patients who had received inadequate treatment with inhaled steroid or steroid tablets and/or inadequate objective monitoring of their asthma. Follow up was inadequate in some and others should have been referred earlier for specialist advice. Asthma deaths are associated with fewer general practice contacts and more home visits.⁷⁸⁰ 2++
There was widespread under-use of written management plans. Heavy or increasing use of β_2 agonist therapy was associated with asthma death.^{381-385,387,388}

2009

Deaths continue to be reported following inappropriate prescription of β -blockers and NSAIDs; all asthma patients should be asked about past reactions to these agents (see section 4.7.7).

2009

Patients with acute asthma should not be sedated unless this is to allow anaesthetic or intensive care procedures (see section 6.3.12).⁷⁸¹

6.1.3 ADVERSE PSYCHOSOCIAL AND BEHAVIOURAL FACTORS

Behavioural and adverse psychosocial factors were recorded in the majority of patients who died of asthma.³⁸¹⁻³⁸⁵ The most important are shown in Table 9.

Table 9: Patients at risk of developing near-fatal or fatal asthma

A COMBINATION OF SEVERE ASTHMA recognised by one or more of:	
<ul style="list-style-type: none"> ▪ previous near-fatal asthma, eg previous ventilation or respiratory acidosis ▪ previous admission for asthma especially if in the last year ▪ requiring three or more classes of asthma medication ▪ heavy use of β_2 agonist ▪ repeated attendances at ED for asthma care especially if in the last year ▪ "brittle" asthma. 	
AND ADVERSE BEHAVIOURAL OR PSYCHOSOCIAL FEATURES recognised by one or more of:	
<ul style="list-style-type: none"> ▪ non-compliance with treatment or monitoring ▪ failure to attend appointments ▪ fewer GP contacts ▪ frequent home visits ▪ self discharge from hospital ▪ psychosis, depression, other psychiatric illness or deliberate self harm ▪ current or recent major tranquilliser use ▪ denial ▪ alcohol or drug abuse ▪ obesity ▪ learning difficulties ▪ employment problems ▪ income problems ▪ social isolation ▪ childhood abuse ▪ severe domestic, marital or legal stress. 	

2009

Case control studies support most of these observations.^{389,390} Compared with control patients admitted to hospital with asthma, those who died were significantly more likely to have learning difficulties; psychosis or prescribed antipsychotic drugs; financial or employment problems; repeatedly failed to attend appointments or discharged themselves from hospital; drug or alcohol abuse; obesity; or a previous near-fatal attack.

2++

Compared with control patients with asthma in the community, patients who died had more severe disease; more likelihood of a hospital admission or visit to the ED for their asthma in the previous year; more likelihood of a previous near-fatal attack; poor medical management; failure to measure pulmonary function; and non-compliance.

B Healthcare professionals must be aware that patients with severe asthma and one or more adverse psychosocial factors are at risk of death.

Studies comparing near-fatal asthma with deaths from asthma have concluded that patients with near-fatal asthma have identical adverse factors to those described in table 9, and that these contribute to the near-fatal asthma attack.³⁹¹⁻³⁹³ Compared with patients who die, those with near-fatal asthma are significantly younger, are significantly more likely to have had a previous near-fatal asthma attack, are less likely to have concurrent medical conditions, are less likely to experience delay in receiving medical care, and more likely to have ready access to acute medical care.

2+

With near-fatal asthma it is advisable to involve a close relative when discussing future management.

Patients with brittle or difficult asthma should also be identified (see sections 6.2.3 and 7.1.1 and Table 10).

- ☒ Keep patients who have had near-fatal asthma or brittle asthma under specialist supervision indefinitely.

6.1.4 SEASONAL FACTORS

In the UK there is a peak of asthma deaths in people aged up to 44 years in July and August and in December and January in older people.^{391,394} 2⁺⁺

6.1.5 PREDICTION AND PREVENTION OF A SEVERE ASTHMA ATTACK

Most attacks of asthma severe enough to require hospital admission develop relatively slowly over a period of six hours or more. In one study, over 80% developed over more than 48 hours.³⁹⁵⁻⁴⁰⁰ There is, therefore, time for effective action to reduce the number of attacks requiring hospitalisation. There are many similarities between patients who die from asthma, patients with near-fatal asthma and control patients with asthma who are admitted to hospital. 2⁺⁺

- ☒ A respiratory specialist should follow up patients admitted with severe asthma for at least one year after the admission.

6.2 ACUTE ASTHMA IN ADULTS

Annexes 2-4 contain algorithms summarising the recommended treatment for patients presenting with acute or uncontrolled asthma in primary care (*Annex 2*), ED (*Annex 3*), and hospital (*Annex 4*).

6.2.1 RECOGNITION OF ACUTE ASTHMA

Definitions of increasing levels of severity of acute asthma exacerbations are provided in table 10.^{322,401-405} Predicted PEF values⁴⁰⁶ should be used only if the recent best PEF (within two years) is unknown. 2⁺
4

6.2.2 SELF TREATMENT BY PATIENTS DEVELOPING ACUTE OR UNCONTROLLED ASTHMA

Patients with asthma, and all patients with severe asthma, should have an agreed written action plan and their own peak flow meter, with regular checks of inhaler technique and compliance. They should know when and how to increase their medication and when to seek medical assistance. Asthma action plans can decrease hospitalisation for⁴⁰⁷ and deaths from⁴⁰⁸ asthma (see section 9.1).

6.2.3 INITIAL ASSESSMENT

All possible initial contact personnel, eg practice receptionists, ambulance call takers, NHS Direct (England and Wales), NHS24 (Scotland), should be aware that asthma patients complaining of respiratory symptoms may be at risk and should have immediate access to a doctor or trained asthma nurse. The assessments required to determine whether the patient is suffering from an acute attack of asthma, the severity of the attack and the nature of treatment required are detailed in tables 10 and 11. It may be helpful to use a systematic recording process. Proformas have proved useful in the ED setting.⁴⁰⁹

Table 10: Levels of severity of acute asthma exacerbations

Near-fatal asthma	Raised PaCO ₂ and/or requiring mechanical ventilation with raised inflation pressures ³⁹¹⁻³⁹³	
Life threatening asthma	Any one of the following in a patient with severe asthma:	
	Clinical signs	Measurements
	Altered conscious level	PEF < 33% best or predicted
	Exhaustion	SpO ₂ < 92%
	Arrhythmia	PaO ₂ < 8 kPa
	Hypotension	"normal" PaCO ₂ (4.6–6.0 kPa)
	Cyanosis	
	Silent chest	
	Poor respiratory effort	
Acute severe asthma	Any one of: - PEF 33-50% best or predicted - respiratory rate ≥ 25/min - heart rate ≥ 110/min - inability to complete sentences in one breath	
Moderate asthma exacerbation	- Increasing symptoms - PEF > 50-75% best or predicted - no features of acute severe asthma	
Brittle asthma	- Type 1: wide PEF variability (> 40% diurnal variation for > 50% of the time over a period > 150 days) despite intense therapy - Type 2: sudden severe attacks on a background of apparently well controlled asthma	

6.2.4 PREVENTION OF ACUTE DETERIORATION

A register of patients at risk may help primary care health professionals to identify patients who are more likely to die from their asthma. A system should be in place to ensure that these patients are contacted if they fail to attend for follow up.

6.2.5 CRITERIA FOR REFERRAL

D Refer to hospital any patients with features of acute severe or life threatening asthma.

Other factors, such as failure to respond to treatment, social circumstances or concomitant disease, may warrant hospital referral.

Table 11: Initial assessment - the role of symptoms, signs and measurements

2009	Clinical features	Clinical features can identify some patients with severe asthma, eg severe breathlessness (including too breathless to complete sentences in one breath), tachypnea, tachycardia, silent chest, cyanosis, accessory muscle use, altered consciousness or collapse. ^{322, 401-405,782} None of these singly or together is specific. Their absence does not exclude a severe attack.	2 ⁺
2009	PEF or FEV₁	Measurements of airway calibre improve recognition of the degree of severity, the appropriateness or intensity of therapy, and decisions about management in hospital or at home. ^{410, 411} PEF or FEV ₁ are useful and valid measures of airway calibre. PEF is more convenient in the acute situation. PEF expressed as a percentage of the patient's previous best value is most useful clinically. PEF as a percentage of predicted gives a rough guide in the absence of a known previous best value. Different peak flow meters give different readings. Where possible the same or similar type of peak flow meter should be used.	2 ⁺
2009	Pulse oximetry	Measure oxygen saturation (SpO ₂) with a pulse oximeter to determine the adequacy of oxygen therapy and the need for arterial blood gas (ABG) measurement. The aim of oxygen therapy is to maintain SpO₂ 94-98%. ⁷⁸³	2 ⁺ 4
2009	Blood gases (ABG)	Patients with SpO ₂ < 92% (irrespective of whether the patient is on air or oxygen) or other features of life threatening asthma require ABG measurement. ^{322, 401-403, 405,413} SpO ₂ < 92% is associated with a risk of hypercapnea. Hypercapnea is not detected by pulse oximetry. ⁷⁸⁴ In contrast the risk of hypercapnea with SpO ₂ > 92% is much less. ⁷⁸³	2 ⁺ 4
	Chest X-ray	Chest X-ray is not routinely recommended in patients in the absence of: – suspected pneumomediastinum or pneumothorax – suspected consolidation – life threatening asthma – failure to respond to treatment satisfactorily – requirement for ventilation.	4
	Systolic paradox	Systolic paradox (<i>pulsus paradoxus</i>) is an inadequate indicator of the severity of an attack and should not be used. ^{322, 401-405,414}	2 ⁺

6.2.6 CRITERIA FOR ADMISSION

- B** Admit patients with any feature of a life threatening or near-fatal attack.^{381-385, 391,393}
- B** Admit patients with any feature of a severe attack persisting after initial treatment.
^{381-385, 391,393}
- C** Patients whose peak flow is greater than 75% best or predicted one hour after initial treatment may be discharged from ED unless they meet any of the following criteria, when admission may be appropriate:
- still have significant symptoms
 - concerns about compliance
 - living alone/socially isolated
 - psychological problems
 - physical disability or learning difficulties
 - previous near-fatal or brittle asthma
 - exacerbation despite adequate dose steroid tablets pre-presentation
 - presentation at night
 - pregnancy.

Criteria for admission in adults are summarised in annexes 2 and 3.

6.3 TREATMENT OF ACUTE ASTHMA IN ADULTS

6.3.1 OXYGEN

- 2009** Many patients with acute severe asthma are hypoxaemic.⁴¹⁵⁻⁴¹⁸ Supplementary oxygen should be given urgently to hypoxaemic patients, using a face mask, Venturi mask or nasal cannulae with flow rates adjusted as necessary to maintain SpO₂ of 94-98%.⁷⁸³ | 2+
4
- 2009** Hypercapnea indicates the development of near-fatal asthma and the need for emergency specialist/anaesthetic intervention.
- 2009** **C** Give supplementary oxygen to all hypoxaemic patients with acute severe asthma to maintain an SpO₂ level of 94-98%. Lack of pulse oximetry should not prevent the use of oxygen.
- 2009** Oxygen-driven nebulisers are preferred for nebulising β_2 agonist bronchodilators because of the risk of oxygen desaturation while using air-driven compressors.^{322,353,419} | 1++
- 2009** Emergency oxygen should be available in hospitals, ambulances and primary care. A flow rate of 6 l/min is required to drive most nebulisers. Where oxygen cylinders are used, a high flow regulator must be fitted.⁷⁸³ | 4
- 2009** The absence of supplemental oxygen should not prevent nebulised therapy from being administered when appropriate.⁴²⁰ | 4
- 2009** **A** In hospital, ambulance and primary care, nebulised β_2 agonist bronchodilators should preferably be driven by oxygen.

6.3.2 β_2 AGONIST BRONCHODILATORS

- 2009** In most cases inhaled β_2 agonists given in high doses act quickly to relieve bronchospasm with few side effects.⁴²¹⁻⁴²³ There is no evidence for any difference in efficacy between salbutamol and terbutaline. Nebulised adrenaline (epinephrine), a non-selective β_2 agonist, does not have significant benefit over salbutamol or terbutaline.⁷⁸⁵ | 1+
1++

In acute asthma without life threatening features, β_2 agonists can be administered by repeated activations of a pMDI via an appropriate large volume spacer or by wet nebulisation driven by oxygen, if available.⁷⁸⁶ Inhaled β_2 agonists are as efficacious and preferable to intravenous β_2 agonists (meta-analysis has excluded subcutaneous trials) in adult acute asthma in the majority of cases.⁴²⁴ | 1++

Metered dose inhalers with spacers can be used for patients with exacerbations of asthma other than life threatening.⁷⁸⁶ | 1++

A Use high-dose inhaled β_2 agonists as first line agents in acute asthma and administer as early as possible. Reserve intravenous β_2 agonists for those patients in whom inhaled therapy cannot be used reliably.

☒ In acute asthma with life threatening features the nebulised route (oxygen-driven) is recommended.

Parenteral β_2 agonists, in addition to inhaled β_2 agonists, may have a role in ventilated patients or those in extremis; however there is limited evidence to support this.

Most cases of acute asthma will respond adequately to bolus nebulisation of β_2 agonists. Continuous nebulisation of β_2 agonists with an appropriate nebuliser may be more effective than bolus nebulisation in relieving acute asthma for patients with a poor response to initial therapy.⁴²⁵⁻⁴²⁷ | 1+

A In severe asthma that is poorly responsive to an initial bolus dose of β_2 agonist, consider continuous nebulisation with an appropriate nebuliser.

Repeat doses of β_2 agonists at 15-30 minute intervals or give continuous nebulisation of salbutamol at 5-10 mg/hour (requires appropriate nebuliser) if there is an inadequate response to initial treatment. Higher bolus doses, eg 10 mg of salbutamol, are unlikely to be more effective.

6.3.3 STEROID THERAPY

Steroids reduce mortality, relapses, subsequent hospital admission and requirement for β_2 agonist therapy. The earlier they are given in the acute attack the better the outcome.^{428,429} | 1++

A Give steroids in adequate doses in all cases of acute asthma.

Steroid tablets are as effective as injected steroids, provided they can be swallowed and retained.⁴²⁸ Prednisolone 40-50 mg daily or parenteral hydrocortisone 400 mg daily (100 mg six-hourly) are as effective as higher doses.⁴³⁰ For convenience, steroid tablets may be given as 2 x 25 mg tablets daily rather than 8-10 x 5 mg tablets. Where necessary soluble prednisolone (sodium phosphate) 5 mg tablets are available. In cases where oral treatment may be a problem consider intramuscular methylprednisolone 160 mg as an alternative to a course of oral prednisolone.⁷⁸⁷ | 1++

2009

☒ Continue prednisolone 40-50 mg daily for at least five days or until recovery.

Following recovery from the acute exacerbation steroids can be stopped abruptly. Doses do not need tapering provided the patient receives inhaled steroids^{431,432} (apart from patients on maintenance steroid treatment or rare instances where steroids are required for three or more weeks). | 1+

2009

It is not known if inhaled steroids provide further benefit in addition to systemic steroids. Inhaled steroids should however be started, or continued as soon as possible to commence the chronic asthma management plan.^{788,789} | 1++


6.3.4 IPRATROPIUM BROMIDE

Combining nebulised ipratropium bromide with a nebulised β_2 agonist produces significantly greater bronchodilation than a β_2 agonist alone, leading to a faster recovery and shorter duration of admission. Anticholinergic treatment is not necessary and may not be beneficial in milder exacerbations of asthma or after stabilisation.⁴³⁴⁻⁴³⁶


1++

B Add nebulised ipratropium bromide (0.5 mg 4-6 hourly) to β_2 agonist treatment for patients with acute severe or life threatening asthma or those with a poor initial response to β_2 agonist therapy.

6.3.5 MAGNESIUM SULPHATE

 There is some evidence that, in adults, magnesium sulphate has bronchodilator effects.⁷⁹⁰ Experience suggests that magnesium is safe when given by the IV or nebulised route. Trials comparing these routes of administration are awaited.

1++

 Studies report the safe use of nebulised magnesium sulphate, in a dose of 135 mg-1152 mg, in combination with β_2 agonists, with a trend towards benefit in hospital admission.^{791,792} A single dose of IV magnesium sulphate is safe and may improve lung function in patients with acute severe asthma.⁴³⁷


1++

The safety and efficacy of repeated IV doses have not been assessed. Repeated doses could cause hypermagnesaemia with muscle weakness and respiratory failure.

1++

B Consider giving a single dose of IV magnesium sulphate for patients with:

- acute severe asthma who have not had a good initial response to inhaled bronchodilator therapy
- life threatening or near fatal asthma.


 IV magnesium sulphate (1.2-2 g IV infusion over 20 minutes) should only be used following consultation with senior medical staff.

 More studies are needed to determine the optimal route, frequency and dose of magnesium sulphate therapy.

6.3.6 INTRAVENOUS AMINOPHYLLINE

In acute asthma, IV aminophylline is not likely to result in any additional bronchodilation compared to standard care with inhaled bronchodilators and steroids. Side effects such as arrhythmias and vomiting are increased if IV aminophylline is used.⁴³⁸

1++

 Use IV aminophylline only after consultation with senior medical staff.

Some patients with near-fatal asthma or life threatening asthma with a poor response to initial therapy may gain additional benefit from IV aminophylline (5 mg/kg loading dose over 20 minutes unless on maintenance oral therapy, then infusion of 0.5-0.7 mg/kg/hr). Such patients are probably rare and could not be identified in a meta-analysis of trials.⁴³⁸ If IV aminophylline is given to patients on oral aminophylline or theophylline, blood levels should be checked on admission. Levels should be checked daily for all patients on aminophylline infusions.

6.3.7 LEUKOTRIENE RECEPTOR ANTAGONISTS

There is insufficient evidence at present to make a recommendation about the use of leukotriene receptor antagonists in the management of acute asthma.

6.3.8 ANTIBIOTICS

When an infection precipitates an exacerbation of asthma it is likely to be viral. The role of bacterial infection has been overestimated.⁴³⁹ | 1++

B

Routine prescription of antibiotics is not indicated for acute asthma.

6.3.9 HELIOX

2009

The use of heliox, (helium/oxygen mixture in a ratio of 80:20 or 70:30), either as a driving gas for nebulisers, as a breathing gas, or for artificial ventilation in adults with acute asthma is not supported on the basis of present evidence.^{440, 441} A systematic review of ten trials, including 544 patients with acute asthma, found no improvement in pulmonary function or other outcomes in adults treated with heliox, although the possibility of benefit in patients with more severe obstruction exists.^{793, 794} Heliox requires the use of specifically designed or modified breathing circuits and ventilators. | 1+
1++

B

Heliox is not recommended for use in acute asthma outside a clinical trial setting.

6.3.10 INTRAVENOUS FLUIDS

There are no controlled trials, observational or cohort studies of differing fluid regimes in acute asthma. Some patients with acute asthma require rehydration and correction of electrolyte imbalance. Hypokalaemia can be caused or exacerbated by β_2 agonist and/or steroid treatment and must be corrected.

6.3.11 NEBULISED FUROSEMIDE

2009

Although theoretically furosemide may produce bronchodilation, a review of three small trials failed to show any significant benefit of treatment with nebulised furosemide compared to β_2 agonists.⁷⁹⁵ | 1+

6.3.12 REFERRAL TO INTENSIVE CARE

Indications for admission to intensive care or high-dependency units include patients requiring ventilatory support and those with severe acute or life threatening asthma who are failing to respond to therapy, as evidenced by:

- deteriorating PEF
- persisting or worsening hypoxia
- hypercapnea
- arterial blood gas analysis showing fall in pH or rising H^+ concentration
- exhaustion, feeble respiration
- drowsiness, confusion, altered conscious state
- respiratory arrest.^{322, 401}

2+

Not all patients admitted to the Intensive Care Unit (ICU) need ventilation, but those with worsening hypoxia or hypercapnea, drowsiness or unconsciousness and those who have had a respiratory arrest require intermittent positive pressure ventilation. Intubation in such patients is very difficult and should ideally be performed by an anaesthetist or ICU consultant.^{322, 401}

C

All patients transferred to intensive care units should be accompanied by a doctor suitably equipped and skilled to intubate if necessary.

6.3.13 NON-INVASIVE VENTILATION

Non-invasive ventilation (NIV) is well established in the management of ventilatory failure caused by extrapulmonary restrictive conditions and exacerbations of COPD. Hypercapneic respiratory failure developing during an acute asthmatic episode is an indication for urgent ICU admission. It is unlikely that NIV would replace intubation in these very unstable patients but it has been suggested that this treatment can be used safely and effectively.⁴⁴²

4

2009

A Cochrane review found only one trial, with 30 patients, on NIV which showed improvement in hospitalisation rates, discharge from emergency departments and lung function. Larger RCTs are needed to determine the role of NIV in treating patients with acute asthma.⁷⁹⁶

1++

2009



NIV should only be considered in an ICU or equivalent clinical setting.

6.4 FURTHER INVESTIGATION AND MONITORING

2009



- Measure and record PEF 15-30 minutes after starting treatment, and thereafter according to the response. Measure and record PEF before and after nebulised or inhaled β_2 agonist bronchodilator (*at least four times daily*) throughout the hospital stay and until controlled after discharge.

- Record oxygen saturation by oximetry and maintain arterial SpO_2 at 94-98%.
- Repeat measurements of blood gas tensions within one hour of starting treatment if:
 - the initial PaO_2 is < 8 kPa unless SpO_2 is $> 92\%$; or
 - the initial PaCO_2 is normal or raised; or
 - the patient's condition deteriorates.



- Measure them again if the patient's condition has not improved by 4-6 hours.
- Measure and record the heart rate.
- Measure serum potassium and blood glucose concentrations.
- Measure the serum theophylline concentration if aminophylline is continued for more than 24 hours (*aim at a concentration of 10-20mg/l or 55-110 mol/l*).

6.5 ASTHMA MANAGEMENT PROTOCOLS AND PROFORMAS

The use of structured proformas facilitates improvements in the process of care in emergency departments and hospital wards and improves patient outcomes. The use of this type of documentation can assist data collection aimed at determining quality of care and outcomes.^{409,443,445}

2++

6.6 HOSPITAL DISCHARGE AND FOLLOW UP (see annex 4)

6.6.1 TIMING OF DISCHARGE

No single physiological parameter defines absolutely the timing of discharge from an admission with acute asthma. Patients should have clinical signs compatible with home management, be on reducing amounts of β_2 agonist (preferably no more than four hourly) and be on medical therapy they can continue safely at home.


Although diurnal variability of PEF is not always present during an exacerbation, evidence suggests that patients discharged with $\text{PEF} < 75\%$ best or predicted and with diurnal variability $> 25\%$ are at greater risk of early relapse and readmission.^{446,447}

2+

6.6.2 PATIENT EDUCATION

Following discharge from hospital or emergency departments, a proportion of patients re-attend with more than 15% re-attending within two weeks. Some repeat attenders need emergency care, but many delay seeking help, and are under-treated and/or under-monitored.⁴⁴⁸ 2+

Prior to discharge, trained staff should give asthma education. This should include education on inhaler technique and PEF record keeping, with a written PEF and symptom-based action plan being provided allowing the patient to adjust their therapy within recommendations. These measures have been shown to reduce morbidity after the exacerbation and reduce relapse rates.⁴⁴⁹ 1++

 There is some experience of a discrete population of patients who use emergency departments rather than primary care services for their asthma care.⁹⁰ Education has been shown to reduce subsequent hospital admission and improve attendance at scheduled appointments and self management techniques but does not improve re-attendance at emergency departments.⁷⁹⁷ 1++

For the above groups there is a role for a trained asthma liaison nurse based in, or associated with, the emergency department.⁷⁹⁷

See also section 9


6.6.3 FOLLOW UP

A careful history should elicit the reasons for the exacerbation and explore possible actions the patient should take to prevent future emergency presentations.

Medication should be altered depending upon the assessment and the patient provided with an asthma action plan aimed at preventing relapse, optimising treatment and preventing delay in seeking assistance in the future.

Follow up should be arranged prior to discharge with the patient's general practitioner or asthma nurse within two working days; and with a hospital specialist asthma nurse or respiratory physician at about one month after admission.

 In a small RCT follow-up care by a nurse specialist was as effective and safe as that given by a respiratory doctor.⁷⁹⁸ 1+

 Assisting patients in making appointments while being treated for acute asthma in emergency departments may improve subsequent attendance at primary care centres.⁷⁹⁹ 1+

- ☒ It is essential that the patient's primary care practice is informed within 24 hours of discharge from the emergency department or hospital following an asthma exacerbation. Ideally this communication should be directly with a named individual responsible for asthma care within the practice, by means of fax or email.

6.7 ACUTE ASTHMA IN CHILDREN AGED OVER 2 YEARS

6.7.1 CLINICAL ASSESSMENT

Table 12 details criteria for assessment of severity of acute asthma attacks in children. See also annexes 5-7.

Table 12: Clinical features for assessment of severity⁸⁰⁰

Life threatening asthma	Any one of the following in a child with severe asthma:	
	Clinical signs	Measurements
	Silent chest	SpO ₂ < 92%
	Cyanosis	PEF < 33% best or predicted
	Poor respiratory effort	
	Hypotension	
	Exhaustion	
	Confusion	
Acute severe asthma	Can't complete sentences in one breath or too breathless to talk or feed	
	SpO ₂ < 92%	
	PEF 33-50% best or predicted	
	Pulse > 140 in children aged 2-5 years > 125 in children aged > 5 years	
	Respiration > 40 breaths/min aged 2-5 years > 30 breaths/min aged 7-5 years	
Moderate asthma exacerbation	Able to talk in sentences	
	SpO ₂ ≥ 92%	
	PEF ≥ 50% best or predicted	
	Heart rate ≤ 140/min in children aged 2-5 years ≤ 125/min in children > 5 years	
	Respiratory rate ≤ 40/min in children aged 2-5 years ≤ 30/min in children > 5 years	

Before children can receive appropriate treatment for acute asthma in any setting, it is essential to assess accurately the severity of their symptoms. The following clinical signs should be recorded:

- Pulserate
(increasing tachycardia generally denotes worsening asthma; a fall in heart rate in life threatening asthma is a pre-terminal event)
- Respiratory rate and degree of breathlessness
(ie too breathless to complete sentences in one breath or to feed)
- Use of accessory muscles of respiration
(best noted by palpation of neck muscles)
- Amount of wheezing
(which might become biphasic or less apparent with increasing airways obstruction)
- Degree of agitation and conscious level
(always give calm reassurance).

Clinical signs correlate poorly with the severity of airways obstruction.⁴⁵⁰⁻⁴⁵³ Some children with acute severe asthma do not appear distressed. 2⁺⁺

- ☒ Decisions about admission should be made by trained clinicians after repeated assessment of the response to bronchodilator treatment.

6.7.2 PULSE OXIMETRY



Accurate measurements of oxygen saturation are essential in the assessment of all children with acute wheezing. Oxygen saturation monitors should be available for use by all health professionals assessing acute asthma in both primary and secondary care settings.

Low oxygen saturations after initial bronchodilator treatment selects a more severe group of patients.^{450,453}

2++

B

Consider intensive inpatient treatment for children with SpO₂ < 92% in air after initial bronchodilator treatment.

6.7.3 PEF



PEF measurements can be of benefit in assessing children who are familiar with the use of such devices. The best of three PEF measurements, ideally expressed as a percentage of personal best, can be useful in assessing the response to treatment.

A measurement of < 50% predicted PEF or FEV₁ with poor improvement after initial bronchodilator treatment is predictive of a more prolonged asthma attack.

6.7.4 CHEST X-RAY

Chest X-rays rarely provide additional useful information and are not routinely indicated.^{454,455}



A chest X-ray should be performed if there is subcutaneous emphysema, persisting unilateral signs suggesting pneumothorax, lobar collapse or consolidation and/or life threatening asthma not responding to treatment.

6.7.5 BLOOD GASES



Blood gas measurements should be considered if there are life threatening features not responding to treatment. Arteriolised ear lobe blood gases can be used to obtain an accurate measure of pH and pCO₂.⁷⁸³ If ear lobe sampling is not practicable a finger prick sample can be an alternative. Normal or raised pCO₂ levels are indicative of worsening asthma. A more easily obtained free flowing venous blood pCO₂ measurement of < 6kPA (45mm Hg) excludes hypercapnia.⁷⁸³

4

6.8 INITIAL TREATMENT OF ACUTE ASTHMA IN CHILDREN AGED OVER 2 YEARS



There is good evidence supporting recommendations for the initial treatment of acute asthma presenting to primary and secondary healthcare resources. There is less evidence to guide the use of second line therapies to treat the small number of severe cases poorly responsive to first line measures. Despite this, the risks of death and other adverse outcomes after admission to hospital are extremely small irrespective of the treatment options chosen.



β₂ agonists should be given as first line treatment. Increase β₂ agonist dose by two puffs every two minutes according to response up to ten puffs.



Children with acute asthma at home and symptoms not controlled by up to 10 puffs of salbutamol via pMDI and spacer, or 2.5-5 mg of nebulised salbutamol, should seek urgent medical attention. Additional doses of bronchodilator should be given as needed whilst awaiting medical attention if symptoms are severe.



Paramedics attending to children with acute asthma should administer nebulised salbutamol driven by oxygen if symptoms are severe whilst transferring the child to the emergency department.



Children with severe or life threatening asthma should be transferred to hospital urgently.

Emergency units attending to children with acute asthma should have a registered sick children's nurse available on duty at all times and staff familiar with the specific needs of children. Using a proforma can increase the accuracy of severity assessment.

2009 → The use of an assessment-driven algorithm and an integrated care pathway has been shown to reduce hospital stay without substantial increases in treatment costs.⁸⁰¹

D The use of structured care protocols detailing bronchodilator usage, clinical assessment, and specific criteria for safe discharge is recommended.

6.8.1 OXYGEN

☒ Children with life threatening asthma or $\text{SpO}_2 < 94\%$ should receive high flow oxygen via a tight fitting face mask or nasal cannula at sufficient flow rates to achieve normal saturations.

6.8.2 INHALED β_2 AGONISTS (SALBUTAMOL/TERBUTALINE)

A Inhaled β_2 agonists are the first line treatment for acute asthma.⁴⁵⁷⁻⁴⁶⁰

Assessment of response should be based on accurately recorded clinical observations and repeat measurements of oxygenation (SpO_2). Children receiving β_2 agonists via pMDI + spacer are less likely to have tachycardia and hypoxia than when the same drug is given via a nebuliser.³⁵³ | 1+

A pMDI + spacer is the preferred option in mild to moderate asthma.

Children aged < 3 years are likely to require a face mask connected to the mouthpiece of a spacer for successful drug delivery. Inhalers should be actuated into the spacer in individual puffs and inhaled immediately by tidal breathing (for five breaths).

Frequent doses of β_2 agonists are safe for the treatment of acute asthma,⁴⁵⁷⁻⁴⁵⁹ although children with mild symptoms benefit from lower doses.⁴⁶⁰ | 1+

B Individualise drug dosing according to severity and adjust according to the patient's response.

2009 → Two to four puffs of a salbutamol 100 mcg repeated every 10-20 minutes according to clinical response might be sufficient for mild attacks although up to 10 puffs might be needed for more severe asthma. Single puffs should be given one at a time and inhaled separately with five tidal breaths. If hourly doses of bronchodilators are needed for more than 4-6 hours, the patient should be switched to nebulised bronchodilators.

2009 → Children with severe or life threatening asthma ($\text{SpO}_2 < 92\%$) should receive frequent doses of nebulised bronchodilators driven by oxygen (2.5-5 mg salbutamol or 5-10 mg terbutaline).

2009 → Doses can be repeated every 20-30 minutes. Continuous nebulised β_2 agonists are of no greater benefit than the use of frequent intermittent doses in the same total hourly dosage.^{463,464} If there is poor response to the initial dose of β_2 agonists, subsequent doses should be given in combination with nebulised ipratropium bromide.

2009 → ☒ Discontinue long-acting β_2 agonists when short-acting β_2 agonists are required more often than four-hourly.

6.8.3 IPRATROPIUM BROMIDE

2009 → There is good evidence for the safety and efficacy of frequent doses of ipratropium bromide (every 20-30 minutes) used in addition to β_2 agonists for the first two hours of a severe asthma attack. Benefits are more apparent in the most severe patients.⁴⁷¹ | 1+

A If symptoms are refractory to initial β_2 agonist treatment, add ipratropium bromide (250 mcg/dose mixed with the nebulised β_2 agonist solution).

2009

Frequent doses up to every 20-30 minutes (250 mcg/dose mixed with 5 mg of salbutamol solution in the same nebuliser) should be used for the first few hours of admission. Salbutamol dose should be weaned to one-to two-hourly thereafter according to clinical response. The ipratropium dose should be weaned to four-to-six-hourly or discontinued. Once improving on two- to four-hourly salbutamol, patients should be switched to pMDI and spacer treatment as tolerated.

- ☒ Repeated doses of ipratropium bromide should be given early to treat children who are poorly responsive to β_2 agonists.

6.8.4 STEROID THERAPY

Steroid tablets

2009

The early use of steroids in emergency departments and assessment units can reduce the need for hospital admission and prevent a relapse in symptoms after initial presentation.^{428, 429} Benefits can be apparent within three to four hours.

A

Give prednisolone early in the treatment of acute asthma attacks.

A soluble preparation dissolved in a spoonful of water is preferable in those unable to swallow tablets. Use a dose of 20 mg for children 2-5 years old and 30-40 mg for children > 5 years.

Oral and intravenous steroids are of similar efficacy.^{430, 465, 466} Intravenous hydrocortisone (4 mg/kg repeated four-hourly) should be reserved for severely affected children who are unable to retain oral medication. | 1+

Larger doses do not appear to offer a therapeutic advantage for the majority of children.⁴⁶⁷ There is no need to taper the dose of steroid tablets at the end of treatment. | 2+

- ☒ Use a dose of 20 mg prednisolone for children aged 2-5 years and a dose of 30-40 mg for children > 5 years. Those already receiving maintenance steroid tablets should receive 2 mg/kg prednisolone up to a maximum dose of 60 mg.
 - Repeat the dose of prednisolone in children who vomit and consider intravenous steroids in those who are unable to retain orally ingested medication.
 - Treatment for up to three days is usually sufficient, but the length of course should be tailored to the number of days necessary to bring about recovery. Weaning is unnecessary unless the course of steroids exceeds 14 days.^{431, 432}

Inhaled steroids

There is insufficient evidence to support the use of inhaled steroids as alternative or additional treatment to steroid tablets for acute asthma.^{433, 468-470}

- ☒ Do not initiate inhaled steroids in preference to steroid tablets to treat children with acute asthma.

Children with chronic asthma not receiving regular preventative treatment will benefit from initiating inhaled steroids as part of their long term management. There is no evidence that increasing the dose of inhaled steroids is effective in treating acute symptoms, but it is good practice for children already receiving inhaled steroids to continue with their usual maintenance doses.

6.8.5 LEUKOTRIENE RECEPTOR ANTAGONISTS

2009

Initiating oral montelukast in primary care settings, early after the onset of acute asthma symptoms, can result in decreased asthma symptoms and the need for subsequent healthcare attendances in those with mild exacerbations.^{777, 802} There is no clear evidence to support the use of leukotriene receptor antagonists for moderate to severe acute asthma.⁸⁰³ | 1+

6.9 SECOND LINE TREATMENT OF ACUTE ASTHMA IN CHILDREN AGED OVER 2 YEARS

2009 Children with continuing severe asthma despite frequent nebulised β_2 agonists and ipratropium bromide plus oral steroids, and those with life threatening features, need urgent review by a specialist with a view to transfer to a high dependency unit or paediatric intensive care unit (PICU) to receive second line intravenous therapies. There are three options to consider; salbutamol, aminophylline and magnesium sulphate.

6.9.1 IV SALBUTAMOL

The role of intravenous β_2 agonists in addition to nebulised treatment remains unclear.⁴²⁴ One study has shown that an IV bolus of salbutamol given in addition to near-maximal doses of nebulised salbutamol results in clinically significant benefits for those with moderate to severe asthma.⁴²⁴

1+

B Consider early addition of a single bolus dose of intravenous salbutamol (15 mcg/kg over 10 minutes) *in* severe cases where the patient has not responded to initial inhaled therapy.

2009 A continuous intravenous infusion of salbutamol should be considered when there is uncertainty about reliable inhalation or for severe refractory asthma. This should be given in a high dependency unit with continuous ECG monitoring and twice daily electrolyte monitoring. Doses above 1-2 mcg/kg/min (200 mcg/ml solution) should be given in a PICU setting (up to 5 mcg/kg/min). Nebulised bronchodilators should be continued while the patient is receiving intravenous bronchodilators. Once the patient is improving the intravenous infusion should be reduced before reducing the frequency of nebulised bronchodilators.

2009 ☒ When inserting an IV cannula take a blood sample to measure serum electrolytes. Serum potassium levels are often low after multiple doses of β_2 agonists and should be replaced.

6.9.2 IV AMINOPHYLLINE

2009 There is no evidence that aminophylline is of benefit for mild to moderate asthma and side effects are common and troublesome.^{438, 472} One well conducted study has shown evidence of benefit in severe acute asthma unresponsive to multiple doses of β_2 agonists and steroids, although the loading dose used was double that currently recommended in the UK and a third of patients were withdrawn from active medication because of vomiting.⁴⁷³ Two studies have compared intravenous β_2 agonists with intravenous theophylline/aminophylline. One demonstrated equivalence.⁸⁰⁴ The other resulted in a shorter period of inpatient treatment among the children receiving an aminophylline bolus followed by infusion but in the salbutamol arm of the study an infusion was not given after the bolus dose.⁸⁰⁵

1+
2+

A Aminophylline is not recommended in children with mild to moderate acute asthma.

2009 **C** Consider aminophylline in a HDU or PICU setting for children with severe or life threatening bronchospasm unresponsive to maximal doses of bronchodilators **plus** steroids.

A 5 mg/kg loading dose should be given over 20 minutes with ECG monitoring (omit in those receiving maintenance oral theophyllines) followed by a continuous infusion at 1 mg/kg/hour. Measure serum theophylline levels in patients already receiving oral treatment and in those receiving prolonged treatment.

6.9.3 IV MAGNESIUM SULPHATE

Intravenous magnesium sulphate is a safe treatment for acute asthma although its place in management is not yet established.^{437,475} Doses of up to 40 mg/kg/day (maximum 2 g) by slow infusion have been used. Studies of efficacy for severe childhood asthma unresponsive to more conventional therapies have been inconsistent in providing evidence of benefit.

1+

6.9.4 OTHER THERAPIES

There is no evidence to support the use of heliox, DNase or mucolytics for the treatment of acute asthma in childhood. Nebulised magnesium sulphate is being evaluated as a treatment for acute asthma but is not yet recommended.

There is insufficient evidence to support or refute the role of antibiotics in acute asthma,³⁰⁵ but the majority of acute asthma attacks are triggered by viral infection.



Do not give antibiotics routinely in the management of children with acute asthma.

6.9.5 DISCHARGE PLANNING

Children can be discharged when stable on 3-4 hourly inhaled bronchodilators that can be continued at home.⁴⁷⁶ PEF and/or FEV₁ should be >75% of best or predicted and SpO₂ >94%.

Adult studies show that “optimal care” comprising self monitoring, regular review and a written asthma action plan can improve outcomes.⁴⁰⁷ Acute asthma attacks should be considered a failure of preventive therapy and thought should be given about how to help families avoid further severe episodes.

Discharge plans should address the following:

2009

- check inhaler technique
- consider the need for preventer treatment
- provide a written asthma action plan for subsequent asthma exacerbations with clear instructions about the use of bronchodilators and the need to seek urgent medical attention in the event of worsening symptoms not controlled by up to 10 puffs of salbutamol 4 hourly
- arrange follow up by primary care services within 48 hours
- arrange follow up in a paediatric asthma clinic within one to two months
- arrange referral to a paediatric respiratory specialist if there have been life threatening features.

2009

6.10 ASSESSMENT OF ACUTE ASTHMA IN CHILDREN AGED LESS THAN 2 YEARS

The assessment of acute asthma in early childhood can be difficult (*see Annex 8*). Intermittent wheezing attacks are usually due to viral infection and the response to asthma medication is inconsistent. Prematurity and low birth weight are risk factors for recurrent wheezing. The differential diagnosis of symptoms includes aspiration pneumonitis, pneumonia, bronchiolitis, tracheomalacia, and complications of underlying conditions such as congenital anomalies and cystic fibrosis. These guidelines are intended for those who are thought to have asthma causing acute wheeze. They should not be used as a guide for treating acute bronchiolitis (*see SIGN 91: Bronchiolitis in children*).⁸⁰⁶

6.11 TREATMENT OF ACUTE ASTHMA IN CHILDREN AGED LESS THAN 2 YEARS

6.11.1 β_2 AGONIST BRONCHODILATORS

A trial of bronchodilator therapy should be considered when symptoms are of concern. If inhalers have been successfully administered but there is no response, review the diagnosis and consider the use of other treatment options.

Inhaled β_2 agonists are the initial treatment of choice for acute asthma. Close fitting face masks are essential for optimal drug delivery. The dose received is increased if the child is breathing appropriately and not taking large gasps because of distress and screaming.

There is good evidence that pMDI + spacer is as effective as, if not better than, nebulisers for treating mild to moderate asthma in children aged ≤ 2 years.^{355,478,479} 1+

A For mild to moderate acute asthma, a pMDI + spacer is the optimal drug delivery device.

Whilst β_2 agonists offer marginal benefits to children aged < 2 years with acute wheeze, there is little evidence for an impact on the need for hospital admission or length of hospital stay.⁴⁸⁰⁻⁴⁸² 1+

Oral β_2 agonists have not been shown to affect symptom score or length of hospital stay for acute asthma in infancy when compared to placebo.⁴⁷⁷ 1+

B Oral β_2 agonists are not recommended for acute asthma in infants.

6.11.2 STEROID THERAPY

Steroid tablets in conjunction with β_2 agonists have been shown to reduce hospital admission rates when used in the emergency department.⁴⁸³ Steroid tablets have also been shown to reduce the length of hospital stay.^{477,480,483} 1+

B Consider steroid tablets in infants early in the management of severe episodes of acute asthma in the hospital setting.

One study has shown similar benefits when comparing oral and nebulised steroids for acute asthma.⁴⁸⁰

☒ Steroid tablet therapy (*10 mg of soluble prednisolone for up to three days*) is the preferred steroid preparation for use in this age group.

6.11.3 IPRATROPIUM BROMIDE

The addition of ipratropium bromide to β_2 agonists for acute severe asthma may lead to some improvement in clinical symptoms and reduce the need for more intensive treatment. It does not reduce the length of hospital stay either in combination with β_2 agonists or in comparison with placebo.⁴⁸⁴ 1+

B Consider inhaled ipratropium bromide in combination with an inhaled β_2 agonist for more severe symptoms.

6.11.4 FURTHER INVESTIGATION AND MONITORING

Many children with recurrent episodes of viral-induced wheezing in infancy do not go on to have chronic atopic asthma. The majority do not require treatment with regular inhaled steroids. Parents should be advised about the relationship between cigarette smoke exposure and wheezy illnesses (see sections 3.1.9 and 3.3.1). Referral to suitable agencies should be offered to those who wish to give up smoking.

Parents of wheezy infants should receive appropriate discharge plans along similar lines to those given for older children (see section 6.9.5).

7 Special situations

7.1 DIFFICULT ASTHMA

7.1.1 DEFINING AND ASSESSING DIFFICULT ASTHMA

The term difficult asthma generally refers to a clinical situation where a prior diagnosis of asthma exists, and asthma-like symptoms and exacerbations persist, despite prescription of high-dose asthma therapy. There is no universally agreed definition of difficult asthma in children or adults, and specifically at what level of treatment prescription or exacerbation frequency, the term difficult asthma should apply. Consequently there are no precise data on the prevalence of this clinical problem. Previous consensus studies have suggested failure to achieve symptom control despite prescribed high-dose inhaled steroid as a minimum requirement, whilst more recent consensus work has stipulated a treatment level equivalent to at least step 4 (see *section 4.4 and Figures 4, 5 and 6*), before labelling as “difficult”.^{485,486}

In this guideline difficult asthma is defined as persistent symptoms and/or frequent exacerbations despite treatment at step 4 or step 5.

Observational uncontrolled studies in subjects with difficult asthma, using multidisciplinary assessment models have identified high rates of alternative or coexistent diagnoses and psychological comorbidity.^{29,487-489} These uncontrolled studies, using systematic multidisciplinary assessment and management, have suggested improved outcomes in adults and children, but controlled clinical trials are required. Within this broadly defined group of subjects with difficult asthma, a proportion will have refractory disease, which is relatively resistant to currently available therapies. This group can only be identified after detailed evaluation, including exclusion of alternative causes of persistent symptoms, management of other comorbidities and confirmation of adherence with therapy.

3

D Patients with difficult asthma should be systematically evaluated, including:

- confirmation of the diagnosis of asthma and
- identification of the mechanism of persisting symptoms and assessment of adherence with therapy.

D This assessment should be facilitated through a dedicated multidisciplinary difficult asthma service, by a team experienced in the assessment and management of difficult asthma.

7.2 FACTORS CONTRIBUTING TO DIFFICULT ASTHMA

7.2.1 POOR ADHERENCE

Poor adherence with asthma medication is associated with poor asthma outcome in adults and children (see *section 9.2*). Few studies have addressed this issue in subjects defined as having difficult asthma. In a case control series, poor adherence based on prescription records was identified in 22% of children with difficult to control asthma, though adherence was not reported in the stable controls.⁴⁹⁰ In a descriptive study of 100 adult subjects, with a physician diagnosis of ‘severe asthma’ 28 patients were on > 15 mg prednisolone and of these nine (32%) were found to be non-adherent with prednisolone.⁴⁸⁸ There is no published evidence that poor adherence, if identified, can be successfully addressed in this population.

2+
3

C Poor adherence with maintenance therapy should be considered as a possible mechanism in difficult asthma.

7.2.2 PSYCHOSOCIAL FACTORS

Fatal and near-fatal asthma have been associated with psychosocial dysfunction (see section 6.1.3). Most observational studies^{29, 488, 491-494} and a case control study⁴⁹⁵ in subjects with difficult asthma have also suggested a high level of psychological morbidity, though this observation has not been universal.^{496, 497}

3
2+

A meta-analysis of behavioural adjustment in children suggested increasing 'asthma severity', defined on the basis of treatment requirements was associated with greater behavioural difficulties.⁴⁹⁸ The core issue of 'cause and effect' remains unclear; specifically the extent to which persistent asthma symptoms despite aggressive treatment results in psychological morbidity or whether pre-existing psychological morbidity makes asthma difficult to control.

2++

There is a lack of evidence that interventions specifically targeting psychological morbidity in difficult asthma are of benefit. A small proof of concept study targeting depression demonstrated a reduction in oral steroid use⁴⁹⁹ and an observational study in 'high-risk' children with asthma suggested potential benefit from joint consultation with a child psychiatrist with an improvement in symptom scores and adherence with therapy.⁵⁰⁰ However, a non-blinded randomised intervention study in adults with difficult asthma showed no benefit from a six month nurse-delivered psychoeducational programme.⁵⁰¹ A meta-analysis of psychoeducational interventions in difficult asthma concluded that many of the studies were of poor quality, though there was some evidence of positive effect of psychosocial educational interventions on hospital admissions in adults and children and on symptoms in children. There was not enough evidence to warrant significant changes in clinical practice and little information available on cost effectiveness.⁵⁰²

1+
3

C Healthcare professionals should be aware that difficult asthma is commonly associated with coexistent psychological morbidity.

D Assessment of coexistent psychological morbidity should be performed as part of a difficult asthma assessment. In children this may include a psychosocial assessment of the family.

7.2.3 DYSFUNCTIONAL BREATHING

Observational uncontrolled studies in subjects with difficult asthma have identified high rates of dysfunctional breathing as an alternative or concomitant diagnosis to asthma causing symptoms.^{29, 488} It remains unclear what is the best mechanism of identifying and managing this problem.

3

D Dysfunctional breathing should be considered as part of a difficult asthma assessment.

7.2.4 ALLERGY

Acute asthma has been associated with IgE dependent sensitisation to indoor allergens.⁵⁰³ In case control studies, mould sensitisation has been associated with recurrent admission to hospital and oral steroid use^{504, 505} and with intensive care unit admissions and respiratory arrest.^{506, 507} There is no published evidence of any intervention study in this group. Research in this area is required.

2++
3

C In patients with difficult asthma and recurrent hospital admission, allergen testing to moulds should be performed.

7.2.5 MONITORING AIRWAY RESPONSE

Two randomised blinded controlled trials and one open randomised study have supported the use of titrating steroid treatment against sputum eosinophilia in adults with moderate to severe asthma, with greatest benefit seen in patients receiving higher doses of inhaled steroid therapy.^{84,86,508} In the study with the largest numbers of patients receiving high dose inhaled steroid treatment, patients who were considered to be poorly adherent with treatment, or had inadequately controlled aggravating factors, such as rhinitis or gastro-oesophageal reflux were specifically excluded.⁸⁴ Case series have suggested that sputum induction is safe in patients with difficult to control asthma.^{57,509-512}

1+
1-
3

Controlled studies using FENO to target treatment have not specifically targeted adults or children with difficult asthma.^{85,513,514}

1+

B

In patients with difficult asthma, consider monitoring induced sputum eosinophil counts to guide steroid treatment.

Revised
2009

7.3 ASTHMA IN PREGNANCY

7.3.1 NATURAL HISTORY AND MANAGEMENT OF STABLE ASTHMA

The majority of women with asthma have normal pregnancies and the risk of complications is small in those with well controlled asthma. Several physiological changes occur during pregnancy that could worsen or improve asthma, but it is not clear which, if any, are important in determining the course of asthma during pregnancy. Pregnancy can affect the course of asthma and asthma and its treatment can affect pregnancy outcomes.

Course of asthma in pregnancy

The natural history of asthma during pregnancy is extremely variable. In a prospective cohort study of 366 pregnancies in 330 women with asthma, the asthma worsened during pregnancy in 35%.⁵¹⁵ A more recent prospective cohort study of 1,739 pregnant women showed an overall improvement in 23% and deterioration in 30.3%.⁸⁰⁷ The conclusions of a meta-analysis of 14 studies is in agreement with the commonly quoted generalisation that during pregnancy about one third of asthma patients experience an improvement in their asthma, one third experience a worsening of symptoms, and one third remain the same.⁵¹⁸ There is also some evidence that the course of asthma is similar in successive pregnancies.^{515,808} A systematic review showed no effect of pregnancy or stage of pregnancy on FEV₁.⁸⁰⁹

2009

1+
2+

2009

Studies suggest that 11-18% of pregnant women with asthma will have at least one emergency department visit for acute asthma and of these 62% will require hospitalisation.^{516,517} Severe asthma is more likely to worsen during pregnancy than mild asthma,⁵¹⁵ but some patients with very severe asthma may experience improvement, whilst symptoms may deteriorate in some patients with mild asthma. In a large US study, the rates of asthma exacerbation were 13%, 26% and 52% in those with mild, moderate and severe asthma respectively.⁸⁰⁷ The corresponding rates of hospitalisation were 2%, 7% and 27%.

2009

2-
2+

2009

A systematic review concluded that, if symptoms do worsen, this is most likely in the second and third trimesters, with the peak in the sixth month.⁸⁰⁸ In a large cohort study, the most severe symptoms were experienced by patients between the 24th and 36th week of pregnancy. Thereafter symptoms decreased significantly in the last four weeks and 90% had no asthma symptoms during labour or delivery. Of those who did, only two patients required anything more than inhaled bronchodilators.⁵¹⁵ A further study has confirmed the observation that the last month of pregnancy is the one in which patients are least likely to have an asthma exacerbation.⁵¹⁹

2+

Effect of asthma on pregnancy

A systematic review has shown that baseline asthma severity does determine what happens to the course of asthma in pregnancy and asthma may affect the risk of adverse outcomes.⁵²¹

A cohort study comparing 198 pregnant women with asthma to 198 women without asthma reported that non-atopic patients with asthma tend to have more severe asthma. Pre-eclampsia was also more common in this group. However with adequate surveillance and treatment, pregnancy and delivery complications can be avoided.⁵²⁰

2++
2+

Uncontrolled asthma is associated with many maternal and fetal complications, including hyperemesis, hypertension, pre-eclampsia, vaginal haemorrhage, complicated labour, fetal growth restriction, pre-term birth, increased perinatal mortality, and neonatal hypoxia.^{522-525,}

⁸⁰⁷ A large Swedish population based study using record linkage data demonstrated increased risks for pre-term birth, low birth weight, perinatal mortality and pre-eclampsia in women with asthma. The risks for pre-term delivery and low birth weight were higher in women with more severe asthma necessitating admission.⁵²⁶

2+

A large prospective cohort study comparing women with moderate and severe asthma with women without asthma found the only significant difference was an increased Caesarean section rate (OR 1.4, 95% CI, 1.1 to 1.8).⁸⁰⁷ Logistic regression analysis of the severe group showed an increased risk of gestational diabetes (AOR 3 (95% CI, 1.2 to 7.8)) and pre-term delivery < 37 weeks (AOR 2.2 95% CI, 1.2 to 4.2) but this could have been an effect of corticosteroids. In the Yale asthma study no effect of asthma symptoms or severity was seen on pre-term delivery but oral steroids increased the rate of pre-term delivery and reduced gestation by 2.2 weeks (AOR 1.05 95% CI, 1.01 to 1.09).⁸¹⁰ Daily asthma symptoms were associated with an increased risk of fetal growth restriction (AOR 2.25 95% CI, 1.25 to 4.06) and there was a 24% increase with each increased symptom step. This is supported by a systematic review of four studies that concluded asthma exacerbation in pregnancy increases the risk of low birth weight.⁸¹¹ The RR was 2.54 (95% CI, 1.52 to 4.25) compared to women without asthma. In a large cohort study of 2,123 women with asthma, there was an association of both mean FEV₁ and mean FEV₁ < 80% predicted with gestational hypertension, pre-term delivery < 37 weeks, < 32 weeks and low birth weight.⁸¹²

2009

2+
2++

In contrast, if asthma is well controlled throughout pregnancy there is little or no increased risk of adverse maternal or fetal complications.^{515,516} Pregnancy should therefore be an indication to optimise therapy and maximise lung function in order to reduce the risk of acute exacerbation.

2+

2009

C

Monitor pregnant women with moderate/severe asthma closely to keep their asthma well controlled.

2009

B

Women should be advised of the importance of maintaining good control of their asthma during pregnancy to avoid problems for both mother and baby.

☒

Advise women who smoke about the dangers for themselves and their babies and give appropriate support to stop smoking.

7.4 MANAGEMENT OF ACUTE ASTHMA IN PREGNANCY

The management of acute asthma in pregnancy may be affected by concerns about harmful effects of medication on the fetus. In a prospective controlled study of 51 pregnant women and 500 non-pregnant women presenting with acute asthma to an emergency department in Boston, USA, pregnant patients with asthma were less likely to receive appropriate treatment with steroids and, as a result, were more likely to experience ongoing exacerbation at two weeks.⁵²⁷ Available studies give little cause for concern regarding treatment side effects (see section 7.3) and the maternal and fetal risks of uncontrolled asthma are much greater than the risks from using conventional asthma medications for management of acute asthma. In the last four confidential enquiries into maternal deaths in the UK (covering 1994-2005) there were seventeen deaths from asthma.^{528,529 813,814}

2+

- 2009** → Oxygen should be delivered to maintain saturation 94-98% in order to prevent maternal and fetal hypoxia.⁷⁸³ When interpreting arterial blood gases in pregnancy it should be remembered that the progesterone-driven increase in minute ventilation may lead to relative hypocapnia and a respiratory alkalosis, and higher PaO₂^{815, 816} but oxygen saturations are unaltered.⁸¹⁷ Acidosis is poorly tolerated by the fetus. 4
- 2009** → Drug therapy should be given as for a non-pregnant patient with acute asthma, including nebulised β_2 agonists and early administration of steroid tablets.^{515, 517, 519, 522, 523} In severe cases, intravenous β_2 agonists, aminophylline, or intravenous bolus magnesium sulphate can be used as indicated.⁸¹⁸ 2+
- 2009** → Continuous fetal monitoring should be performed when asthma is uncontrolled or severe, or when fetal assessment on admission is not reassuring. Consideration should be given to early referral to critical care services as impaired ventilatory mechanics in late pregnancy can lower functional residual capacity and may result in earlier oxygen desaturation.⁸¹⁹ Pregnant women may be more difficult to intubate due to anatomical changes especially if they have pre-eclampsia.⁸²⁰
- 2009** → **C** Give drug therapy for acute asthma as for the non-pregnant patient including systemic steroids and magnesium sulphate.
- 2009** → **D** Deliver high flow oxygen immediately to maintain saturation 94-98%.
- D** Acute severe asthma in pregnancy is an emergency and should be treated vigorously in hospital.
- ☒ Continuous fetal monitoring is recommended for severe acute asthma.
- 2009** → ☒ For women with poorly controlled asthma during pregnancy there should be close liaison between the respiratory physician and obstetrician, with early referral to critical care physicians for women with acute severe asthma.

7.5 DRUG THERAPY IN PREGNANCY

- 2009** → In general, the medicines used to treat asthma are safe in pregnancy.^{530, 821} A large UK population based case control study found no increased risk of major congenital malformations in children of women receiving asthma treatment in the year before or during pregnancy.⁸²² The risk of harm to the fetus from severe or chronically under-treated asthma outweighs any small risk from the medications used to control asthma. 2+
- 2009** → **B** Counsel women with asthma regarding the importance and safety of continuing their asthma medications during pregnancy to ensure good asthma control.

7.5.1 β_2 AGONISTS

- No significant association has been demonstrated between major congenital malformations or adverse perinatal outcome and exposure to short-acting β_2 agonists.^{530, 531, 821-823} A prospective study of 259 pregnant patients with asthma who were using bronchodilators compared with 101 pregnant patients with asthma who were not, and 295 control subjects, found no differences in perinatal mortality, congenital abnormalities, prematurity, mean birth weight, apgar scores or labour/delivery complications.⁵³² A case control study including 2,460 infants exposed to short-acting β_2 agonists found no increased risk of congenital malformations in exposed infants.⁸⁰⁷ 2+
3
- 2009** → With regard to long-acting β_2 agonists (LABAs), evidence from prescription event monitoring suggests that salmeterol is safe in pregnancy⁵³³ and although there are some data on formoterol, numbers are small.⁸²⁴ Systematic review of studies including 190 exposures to LABA demonstrated no increased risk of congenital malformations, pre-term delivery or pre-eclampsia.⁸²⁵ A case control study including 156 infants exposed to LABA found no increased risk of major congenital malformations.⁸²² As in other settings, LABAs should be used with an inhaled corticosteroid, ideally as a combination product.⁸²⁶ 2+

2009 Data on the use of combination products in pregnancy are scarce although there are no theoretical reasons why these would be more harmful than the same agents given separately. There are some safety data for seretide (salmeterol/fluticasone) but with small numbers.⁸²⁷

2009 **B** Use short acting β_2 agonists as normal during pregnancy.

2009 **C** Use long acting β_2 agonists (LABA) as normal during pregnancy.

7.5.2 INHALED STEROIDS

2009 No significant association has been demonstrated between major congenital malformations or adverse perinatal outcome and exposure to inhaled steroids.^{530,534-537, 822, 825, 828} A meta-analysis of four studies of inhaled corticosteroid use in pregnancy showed no increase in the rate of major malformations, pre-term delivery, low birth weight or pregnancy-induced hypertension.⁸²⁹ The UK case control study included 1,429 infants exposed to inhaled steroids and found no increased risk of major congenital malformations.⁸²² 2-
2+
2++

2009 Inhaled anti-inflammatory treatment has been shown to decrease the risk of an acute attack of asthma in pregnancy⁵¹⁹ and the risk of readmission following asthma exacerbation.⁵¹⁷ A randomised placebo controlled trial of inhaled beclometasone versus oral theophylline in moderate asthma in pregnancy showed no difference in the primary outcome of one or more asthma exacerbations resulting in medical intervention, but inhaled beclometasone was better tolerated.⁸⁰⁷ 2+

B Use inhaled steroids as normal during pregnancy.

7.5.3 THEOPHYLLINES

No significant association has been demonstrated between major congenital malformations or adverse perinatal outcome and exposure to methylxanthines.^{530,538} 2+

For women requiring theophylline to maintain asthma control, measurement of theophylline levels is recommended. Since protein binding decreases in pregnancy, resulting in increased free drug levels, a lower therapeutic range is probably appropriate.⁵³⁹ 4

C Use oral and intravenous theophyllines as normal during pregnancy.

D Check blood levels of theophylline in acute severe asthma and in those critically dependent on therapeutic theophylline levels.

7.5.4 STEROID TABLETS

2009 There is much published literature showing that steroid tablets are not teratogenic^{522, 530, 540} but a slight concern that they may be associated with oral clefts. Data from several studies have failed to demonstrate this association with first trimester exposure to steroid tablets^{540, 830} but one case control study found a significant association, although this increase is not significant if only paired controls are considered.⁵⁴² Although one meta-analysis reported an increased risk,⁵⁴¹ a prospective study by the same group found no difference in the rate of major birth defects in prednisolone-exposed and control babies.⁵⁴¹ A more recent population based case control study revealed a crude odds ratio of corticosteroid exposure from four weeks before through to 12 weeks after conception of 1.7 (95% CI, 1.1-2.6) for cleft lip.⁸³¹ Another case control study⁸²² including 262 exposed infants found no such association, although this was not limited to first trimester exposure. 2+
2-

The association is therefore not definite and even if it is real, the benefit to the mother and the fetus of steroids for treating a life threatening disease justify the use of steroids in pregnancy.^{524, 815} Moreover, the various studies of steroid exposure include many patients with conditions other than asthma, and the pattern of steroid use was generally as a regular daily dose rather than as short courses, which is how asthma patients would typically receive oral steroids. 2+

Prednisolone is extensively metabolized by placental enzymes so only 10% reaches the fetus, making this the oral steroid of choice to treat maternal asthma in pregnancy. Pregnant women with acute asthma exacerbation are less likely to be treated with steroid tablets than non-pregnant women.⁵²⁷ Failure to administer steroid tablets when indicated increases the risk of ongoing exacerbation and therefore the risk to the mother and her fetus. 2+

2009 Some studies have found an association between steroid tablet use and pregnancy-induced hypertension or pre-eclampsia, pre-term labour⁵²⁰ and fetal growth but severe asthma may be a confounding variable.⁸³² 2+

2009 **C** Use steroid tablets as normal when indicated during pregnancy for severe asthma. Steroid tablets should never be withheld because of pregnancy. Women should be advised that the benefits of treatment with oral steroids outweigh the risks.

7.5.5 LEUKOTRIENE RECEPTOR ANTAGONISTS

2009 Data regarding the safety of leukotriene antagonists (LTRA) in pregnancy are limited. Animal studies and post-marketing surveillance for zafirlukast with 28 pregnancies with 20 exposed in the first trimester and montelukast are reassuring.⁸³³ There are animal data of concern for zileuton.⁵⁴³ A case control study with 96 cases exposed to LTRAs found no increased risk of major malformations between women with asthma exposed to LTRA and women with asthma taking only beta agonists.⁸³² A systematic review found no increased risk of malformations or pre-term delivery in nine exposed women.^{810, 825} 2-
4
2+
2++

2009 **D** Leukotriene antagonists may be continued in women who have demonstrated significant improvement in asthma control with these agents prior to pregnancy not achievable with other medications.

7.5.6 CHROMONES

No significant association has been demonstrated between major congenital malformations or adverse perinatal outcome and exposure to chromones.^{529, 530, 825, 832} 2+

C Use chromones as normal during pregnancy.

7.5.7 IMMUNOMODULATION THERAPY

2009 There are as yet no clinical data on the use of omalizumab for moderate-severe allergic asthma in pregnancy. There are some reassuring animal studies re teratogenicity (classed as FDA category B). A registry of pregnancy exposures is being undertaken.

7.6 MANAGEMENT DURING LABOUR

Acute attacks of asthma are very rare in labour, perhaps due to endogenous steroid production. In women receiving steroid tablets there is a theoretical risk of maternal hypothalamic-pituitary-adrenal axis suppression. Women with asthma may safely use all forms of usual labour analgesia.

2009 In some studies there is an association between asthma and an increased Caesarean section rate,^{520, 544, 545} but this may be due to planned Caesarean sections⁵¹⁹ or inductions of labour rather than due to any direct effect of asthma on intrapartum indications. A large prospective cohort study comparing women with moderate and severe asthma with women without asthma found the only significant difference was an increased Caesarean section rate (OR 1.4, 95% CI 1.1-1.8).⁸⁰⁷ 2+

Data suggest that the risk of postpartum exacerbation of asthma is increased in women having Caesarean sections.⁵⁴⁴ This may relate to the severity of their asthma rather than to the Caesarean section, or to factors such as postoperative pain with diaphragmatic splinting, hypoventilation and atelectasis. Prostaglandin E2 may safely be used for labour inductions.⁵³⁹ Prostaglandin F2 α (carboprost/hemobate®) used to treat postpartum haemorrhage due to uterine atony may cause bronchospasm.⁵³⁹ Although ergometrine may cause bronchospasm particularly in association with general anaesthesia,⁵³⁹ this is not a problem encountered when syntometrine (syntocinon/ergometrine) is used for postpartum haemorrhage prophylaxis.

2+
3

Although suppression of the fetal hypothalamic-pituitary-adrenal axis is a theoretical possibility with maternal systemic steroid therapy, there is no evidence from clinical practice or the literature to support this.⁵⁴⁶

- ☒ Advise women that acute asthma is rare in labour.
- ☒ Advise women to continue their usual asthma medications in labour.
- ☒ In the absence of acute severe asthma, reserve Caesarean section for the usual obstetric indications.
- C** **If anaesthesia is required, regional blockade is preferable to general anaesthesia in women with asthma.**
- ☒ Women receiving steroid tablets at a dose exceeding prednisolone 7.5 mg per day for more than two weeks prior to delivery should receive parenteral hydrocortisone 100 mg 6-8 hourly during labour.
- D** **Use prostaglandin F2 α with extreme caution in women with asthma because of the risk of inducing bronchoconstriction.**

7.7 DRUG THERAPY IN BREASTFEEDING MOTHERS

The medicines used to treat asthma, including steroid tablets, have been shown in early studies to be safe to use in nursing mothers.⁵⁴⁷ There is less experience with newer agents. Less than 1% of the maternal dose of theophylline is excreted into breast milk.⁵⁴⁷

2+

Prednisolone is secreted in breast milk, but milk concentrations of prednisolone are only 5-25% of those in serum.³⁵¹ The proportion of an oral or intravenous dose of prednisolone recovered in breast milk is less than 0.1%.⁵⁴⁸⁻⁵⁵⁰ For maternal doses of at least 20 mg once or twice daily the nursing infant is exposed to minimal amounts of steroid with no clinically significant risk.⁵⁴⁸⁻⁵⁵⁰

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3

- C** **Encourage women with asthma to breastfeed.**
- C** **Use asthma medications as normal during lactation, in line with manufacturers' recommendations.**

7.8 OCCUPATIONAL ASTHMA

7.8.1 INCIDENCE

The true frequency of occupational asthma is not known, but under-reporting is likely. Published reports, which come from surveillance schemes, compensation registries or epidemiological studies, estimate that occupational asthma may account for about 9-15% of adult onset asthma.⁵⁵¹⁻⁵⁵³ It is now the commonest industrial lung disease in the developed world with over 400 reported causes.⁵⁵⁴⁻⁵⁵⁶

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The diagnosis should be suspected in all adults with symptoms of airflow limitation, and positively searched for in those with high-risk occupations or exposures. Patients with pre-existing asthma aggravated non-specifically by dust and fumes at work (work-aggravated asthma) should be distinguished from those with pre-existing asthma who become additionally sensitised to an occupational agent.

B

In patients with adult onset, or reappearance of childhood asthma, clinicians should be suspicious that there may be an occupational cause.

7.8.2 AT-RISK POPULATIONS

Several hundred agents have been reported to cause occupational asthma and new causes are reported regularly in the medical literature.

The most frequently reported causative agents include isocyanates, flour and grain dust, colophony and fluxes, latex, animals, aldehydes and wood dust.⁵⁵⁷⁻⁵⁶⁵

The workers most commonly reported to occupational asthma surveillance schemes include paint sprayers, bakers and pastry makers, nurses, chemical workers, animal handlers, welders, food processing workers and timber workers.^{557,558,560,562-568}

2++

Workers reported to be at increased risk of developing asthma include bakers, food processors, forestry workers, chemical workers, plastics and rubber workers, metal workers, welders, textile workers, electrical and electronic production workers, storage workers, farm workers, waiters, cleaners, painters, dental workers and laboratory technicians.⁵⁶⁹⁻⁵⁷²

2+

7.8.3 DIAGNOSIS

Occupational asthma should be considered in all workers with symptoms of airflow limitation. The best screening question to ask is whether symptoms improve on days away from work. This is more sensitive than asking whether symptoms are worse at work, as many symptoms deteriorate in the hours after work or during sleep.



Adults with airflow obstruction should be asked:

- Are you better on days away from work?
- Are you better on holiday?

Those with positive answers should be investigated for occupational asthma.

These questions are not specific for occupational asthma and also identify those with asthma due to agents at home (who may improve on holidays), and those who do much less physical exertion away from work.⁵⁷³

Occupational asthma can be present when tests of lung function are normal, limiting their use as a screening tool. Asthmatic symptoms improving away from work can produce false negative diagnoses, so further validation is needed.

Serial measurement of peak respiratory flow is the most readily available initial investigation, and the sensitivity and specificity of serial peak flow measurement in the diagnosis of occupational asthma are high.⁵⁷⁴⁻⁵⁸⁰

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Although skin prick tests or blood tests for specific IgE are available, there are few standardized allergens commercially available which limits their use. A positive test denotes sensitisation, which can occur with or without disease. The diagnosis of occupational asthma can usually be made without specific bronchial provocation testing, considered to be the gold standard diagnostic test. The availability of centres with expertise and facilities for specific provocation testing is very limited in the UK and the test itself is time consuming.

As a general observation, the history is more useful in excluding occupational asthma than in confirming it. A significant proportion of workers with symptoms that improve on days away from work or on holiday have been shown by objective tests not to have occupational asthma.⁵⁸¹ Expert histories have poor specificity compared with specific challenge testing. Free histories taken by experts have high sensitivity but their specificity is lower.⁵⁸²⁻⁵⁸⁷

3

D In suspected work-related asthma, the diagnosis of asthma should be confirmed using standard objective criteria.

7.8.4 SENSITIVITY AND SPECIFICITY OF SERIAL PEAK FLOW MEASUREMENTS

Direct and blinded comparisons of serial peak flow measurement with either specific bronchial provocation testing, or an expert diagnosis based on a combination of other types of evidence, reported consistently high sensitivities and specificities, averaging 80% and 90% respectively.^{575-578,580,588,589}

3

Just one computed method of analysis has been reported, with a sensitivity of 75% and a specificity of 94%.^{97,590}

2+

Computed analysis of peak flow records has good diagnostic performance, but statistical analysis of serial peak flow measurements appears to be of limited diagnostic value compared to expert interpretation.^{578,588,589}

Serial measurements of peak expiratory flow

Measurements should be made every two hours from waking to sleeping for four weeks, keeping treatment constant and documenting times at work.

Minimum standards for diagnostic sensitivity > 70% and specificity > 85% are:

- At least three days in each consecutive work period
- At least three series of consecutive days at work with three periods away from work (usually about three weeks)
- At least four evenly spaced readings per day.⁵⁸⁰

The analysis is best done with the aid of a criterion-based expert system. Suitable record forms and support are available from www.occupationalasthma.com

D Objective diagnosis of occupational asthma should be made using serial peak flow measurements, with at least four readings per day.

7.8.5 NON-SPECIFIC REACTIVITY

Studies of non-specific reactivity are confounded by different methods used, different cut-offs for normality and the interval between last occupational exposure and the performance of the test (increasing time may allow recovery of initial hyper-reactors). Such studies show that non-specific bronchial hyper-reactivity may be normal in 5-40% of specific challenge positive workers. Testing with higher concentrations of methacholine or histamine, at which some people without asthma would react, reduces the number of non-reacting people with occupational asthma, but still leaves some non-reactors. One study showed no additional benefit of non-specific bronchial reactivity measurement over and above a history and specific IgE to inhaled antigens. A normal test of non-specific reactivity is not sufficiently specific to exclude occupational asthma in clinical practice.^{576,581,583,586,587,589,591-602}

2++

Changes in non-specific reactivity at and away from work alone have been found to have only moderate sensitivity and specificity for diagnosis. Three studies were identified where at and away from work exposure measurements were attempted. One did not investigate workers further when at work reactivity was normal, limiting its interpretation. Using a 3.2 fold change in reactivity, one study found a sensitivity of 48% and a specificity of 64%. Reducing the required change to twofold increased the sensitivity to 67%, reducing specificity to 54%. A smaller study with 14 workers with occupational asthma showed a sensitivity of 62% and specificity of 78%.^{577,589,601}

2-

7.8.6 SPECIFIC BRONCHIAL PROVOCATION TESTING

Specific provocation challenges are usually used as the gold standard for occupational asthma diagnosis making assessments of their diagnostic validity difficult. In addition, there are no standardised methods for many occupational agents. There is also evidence that the threshold exposure increases with time since last exposure, making the tests less sensitive after prolonged absence from work. There are reports of people having non-specific reactions to specific challenges at concentrations likely to be found in the workplace or of negative reactions to specific challenges in workers with otherwise good evidence of occupational asthma when challenge concentrations are confined to levels below occupational exposure standards.^{594,597,600,603,604}

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D A negative specific bronchial challenge in a worker with otherwise good evidence of occupational asthma is not sufficient to exclude the diagnosis.

7.9 MANAGEMENT OF OCCUPATIONAL ASTHMA

The aim of management is to identify the cause, remove the worker from exposure, and for the worker to have worthwhile employment.

Complete avoidance of exposure may or may not improve symptoms and bronchial hyper-responsiveness. Both the duration of continued exposure following the onset of symptoms and the severity of asthma at diagnosis may be important determinants of outcome. Early diagnosis and early avoidance of further exposure, either by relocation of the worker or substitution of the hazard offer the best chance of complete recovery. Workers who remain in the same job and continue to be exposed to the same causative agent after diagnosis are unlikely to improve and symptoms may worsen. The likelihood of improvement or resolution of symptoms or of preventing deterioration is greater in workers who have no further exposure to the causative agent.^{576,605-613}

2++

Several studies have shown that the prognosis for workers with occupational asthma is worse for those who remain exposed for more than one year after symptoms develop, compared with those removed earlier.⁶¹⁴⁻⁶¹⁶

D Relocation away from exposure should occur as soon as diagnosis is confirmed, and ideally within 12 months of the first work-related symptoms of asthma.

There is consistent evidence from clinical and workforce case series that about one third of workers with occupational asthma are unemployed after diagnosis. It is unclear whether this risk is higher than that for other adults with asthma.^{582,617,618} The risk of unemployment may fall with increasing time after diagnosis.⁶¹⁹ There is consistent evidence that loss of employment following a diagnosis of occupational asthma is associated with loss of income. Adults with occupational asthma may find employment more difficult than adults with non-occupational asthma.^{617,618} Approximately one third of workers with occupational asthma have been shown to be unemployed up to six years after diagnosis.^{582,617-624}

2-

8 Organisation and delivery of care, and audit

8.1 ROUTINE PRIMARY CARE

8.1.1 ACCESS TO ROUTINE PRIMARY CARE

Primary care services delivered by doctors and nurses trained in asthma management improves diagnosis, prescribing, education, monitoring, and continuity of care.^{625,626} Successful training programmes typically include outreach educational visits to practices or practitioners using interactive educational methods focused around clinical guidelines, occasionally including audit and feedback of care.^{625,627,628}

1+

A All people with asthma should have access to primary care services delivered by doctors and nurses with appropriate training in asthma management.

❖ *Audit the percentage of clinicians who have taken part in a suitable asthma educational update within last two years.*

8.1.2 STRUCTURED REVIEW

Proactive clinical review of people with asthma improves clinical outcomes. Evidence for benefit is strongest when reviews include discussion and use of a written action plan.⁴⁰⁷ Benefits include reduced school or work absence, reduced exacerbation rate, improved symptom control and reduced attendance at the emergency department.^{629,630} Proactive structured review, as opposed to opportunistic or unscheduled review, is associated with reduced exacerbation rate and days lost from normal activity.^{626,631,632} It is difficult to be prescriptive about the frequency of review as need will vary with the severity of the disease. Outcome is probably similar whether a practice nurse (PN), or a general practitioner (GP) conducts the review. Clinicians trained in asthma management achieve better outcomes for their patients.^{626,633,634}

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1+

A In primary care, people with asthma should be reviewed regularly by a nurse or doctor with appropriate training in asthma management. Review should incorporate a written action plan.

❖ *Audit the percentage of patients reviewed annually. Consider focusing on particular groups such as those overusing bronchodilators, patients on higher treatment steps, those with exacerbations or from groups with more complex needs.*

❖ *Audit the percentage of patients receiving action plans. Consider focusing on subgroups listed above.*

READ coding of patients who are newly diagnosed or register at a practice will ensure a meaningful database for audit and review purposes. Specifically identifying patients with high risk asthma (eg those with frequent admissions) in an effort to target more detailed input is logical but supported by limited evidence.⁶³⁵ Not all patients want regular review, or are willing to attend a pre-arranged appointment. Reviews carried out by telephone may be as effective as those using face-to-face consultations,⁶³⁶ but face-to-face review will be appropriate for some patients, such as those with poor asthma control or inhaler-related problems.

2++

B Consider carrying out routine reviews by telephone for people with asthma.

Asthma clinics in primary care may be a convenient way of delivering care, but there is limited evidence that they themselves improve outcome.²⁹¹ Most practices will provide asthma reviews as part of routine appointment sessions. It is what happens during the review consultation that matters.⁶³⁷⁻⁶⁴⁰ Audit that feeds back guidelines recommendations on the management of individual patients may improve outcomes.^{641,642}

C General practices should maintain a register of people with asthma.

C Clinical review should be structured and utilise a standard recording system.

B Feedback of audit data to clinicians should link guidelines recommendations to management of individual patients.

The ideal content of an asthma review consultation is uncertain. Discussion and provision of a written action plan leads to improved outcomes.⁶⁴³ Other activities likely to be important are reviewing understanding of medication role and use, checking inhaler technique, recording lung function. Structured review systems such as the Royal College of Physicians 'Three Key Questions',¹⁰⁹ the Tayside Asthma Stamp,⁶⁴⁴ and the modified Jones Morbidity Index⁶⁴⁵ improve the recording of relevant data and may prompt a search for causes of suboptimal asthma control, such as under-treatment, poor adherence or poor inhaler technique. However, such tools can lead to a more physician-centred or template-directed consultation. Reviewing patients using a patient-centred style of consultation can lead to improved outcomes.⁶²⁵

8.1.3 SHARED CARE

Shared care schemes have been shown to be effective in some healthcare environments. There are no UK studies directly comparing primary and secondary care management, but international work suggests there may be little difference: what is done would appear to be more important than who by or where.⁶⁴⁶

Integrated care schemes such as Grampian Asthma Study in Integrated Care (GRASSIC) suggest that place of care is not directly linked to clinical outcome.⁶⁴⁷⁻⁶⁵⁰ Shared care had a similar outcome to outpatient care. Outreach support for primary care by asthma specialist nurses may reduce unscheduled asthma care but only if targeted around follow-up of patients recently attending secondary care with exacerbations.

Community pharmacists trained in asthma care and teaching self management skills may improve asthma control,^{651,652} although evidence is sparse and inconsistent.⁶⁵³

8.1.4 PATIENT SUBGROUPS

Ethnic subgroups have adverse clinical outcomes, including higher hospital admission and exacerbation rates.^{654,655} In some countries ethnic minority groups have higher death rates due to asthma than do their contemporaries.^{656,657} Minority groups describe poorer access to primary care and acute medical care,⁶⁵⁸ and compared with majority groups, have a higher use of emergency facilities for routine care.⁶⁵⁹ Educating primary care clinicians improves diagnosis, prescribing, education, and continuity of care for minority group children.⁶⁵⁹ There is an established link between poor socioeconomic status and adverse asthma outcome.⁶⁶⁰⁻⁶⁶⁴

Adolescents and the elderly are particularly vulnerable to the adverse effects of asthma. Adolescents and young adults make more frequent use of emergency asthma healthcare services, make less use of structured clinical review services than other age groups, and have high reliance on bronchodilators.^{665,666} Asthma in the elderly is a neglected area of research, despite high mortality and morbidity.^{391,667,668}

D Healthcare professionals who provide asthma care should have heightened awareness of the complex needs of ethnic minorities, socially disadvantaged groups, adolescents, the elderly and those with communication difficulties.

❖ *Audit asthma outcomes in relevant subgroups of the population.*

8.2 ACUTE EXACERBATIONS

People with asthma who experience deterioration in symptom control leading to an acute exacerbation can access a wide variety of sources of care. Few studies have looked at the relative merits of one type of service compared to another. Exceptions include a UK study showing a better outcome for patients managed by a specialist respiratory ward compared to a general medical ward, and a US study showing more favourable outcome in patients managed by specialist allergists compared to generalists.^{669,670}

2+
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C Manage hospital inpatients with asthma in specialist rather than general units.

☑ All services involved in the care of acute asthma should be staffed by appropriately trained personnel and have access to all the equipment needed to manage acute asthma.

❖ *Audit the percentage of inpatients receiving care from specialist asthma nurse or chest physician.*

Models of care addressing access such as NHS Direct/NHS 24 produce similar outcomes to routine general practice, but have high referral rates and are unlikely to promote the continuity of care required for longer term management.⁶⁷¹

3

A structured clinical assessment and a standardised recording system are associated with favourable outcome in acute exacerbations.⁶⁷² Audit of the management of patients with acute asthma attacks is associated with improved concordance with recommended guidelines and in turn improved clinical outcome and reduced exacerbation rate.⁶⁷³⁻⁶⁷⁵

2+
2-
3

There is no evidence that the publication of guidelines per se improves care: clinicians need to link best practice to the management of individual patients. This effect is apparent in hospital and general practice care.⁴⁴⁷ Certain actions, for example early prescription of oral corticosteroids for acute exacerbations of asthma, reduce hospitalisation and relapse rates. Clinicians should refer to relevant chapters in this guideline for advice.

B Clinicians in primary and secondary care should treat asthma according to recommended guidelines.

❖ *Audit the percentage of patients treated according to key guideline recommendations.*

Using acute asthma management protocols and clinical pathways can be beneficial and cost effective. Sub-optimal control of asthma leading to exacerbation is more expensive to manage than well controlled asthma.⁶³⁰ Early discharge schemes from hospital and emergency departments may be cost effective.^{445,676}

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The safety of telephone help lines has not been established. 'Direct dial' emergency admission schemes may be of benefit to a small group of patients with severe or 'brittle' asthma but there is insufficient evidence to justify their widespread introduction.⁶⁷⁷ Admission criteria are discussed elsewhere (see section 6.2.6).

4

Criteria for and timing of discharge from hospital and emergency departments has been studied. The key event in recovery appears to be improved symptoms and peak flow rather than a complete return to normality. Discharge when improvement is apparent may be as safe as discharge when full stability is achieved. Asthma specialist nurse education of adults and school-age (but not pre-school) children at or shortly after hospital attendance improves symptom control, self management and re-attendance rates.⁶⁷⁸⁻⁶⁸³

1+
2+
2+
2-

Making an appointment for review in primary care prior to discharge improves follow-up rates (but not outcomes).⁶⁸⁴ Review within 30 days after hospital attendance with acute asthma is associated with reduced risk of further acute episodes.⁶⁸⁵ There is most evidence of benefit when follow up is provided by specialist nurses. Various types of follow up after an acute exacerbation have been evaluated including GP care, hospital outpatient, and telephone follow up.^{680,686} There would appear to be little difference in outcome depending on place or personnel involved in follow up (see section 6.6).⁶⁷⁶

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1+

A Discharge from hospital or the emergency department should be a planned, supervised event which includes self management planning. It may safely take place as soon as clinical improvement is apparent.

A All people attending hospital with acute exacerbations of asthma should be reviewed by a clinician with particular expertise in asthma management, preferably within 30 days.

❖ Audit the percentage of people receiving specialist nurse advice including self management planning before discharge.

❖ Audit the percentage of people reviewed within 30 days after hospital attendance with acute exacerbation of asthma.

8.3 AUDIT

Audit is a moderately effective way to improve the process and probably outcome of care.⁶⁸⁷ Its impact is increased if combined with other strategies to change clinician behaviour, for example outreach education programmes. Whilst trials of audit in asthma care are few, those showing benefits have tended to incorporate feedback data to clinicians on the process of care such as frequency of review, checking of inhaler technique or lung function measurement. Passive feedback of aggregated data, for instance on prescribing patterns, does not change practice.⁶⁸⁸

8.3.1 TYPES OF AUDIT IN ASTHMA CARE

National or regional audits of asthma deaths have focused attention on delivery of care for severe asthma. Some primary care trusts have PCT-wide programmes of audit which extract practice data electronically and feedback comparative data on process of care, promoting a benchmarking approach to quality improvement.⁶⁸⁹ The GMS Quality and Outcomes Framework (QOF) links audit of asthma care to financial incentives. Critical event audit focuses on an adverse event such as an asthma death, or failure of delivery care. How effective these activities are in improving outcomes of asthma care is uncertain.

Common sense suggests that auditing activities shown to improve patient outcomes is worthwhile. This chapter links suggestions for audit to guideline recommendations. Audit datasets are available at www.brit-thoracic.org.uk.

8.3.2 SUMMARY OF RECOMMENDED AUDITS

Diagnosis

Audit the percentage of adults with an Asthma Control Questionnaire score recorded and an Asthma Control Questionnaire of >0.75.

Non-pharmacological management

Audit the percentage of patients and parents-to be with smoking status recorded and the percentage who have received smoking cessation advice.

Pharmacological management

Audit:

- *the percentage of patients with potential adverse effects of treatment, for example, the percentage of children prescribed or using >800 micrograms/day of inhaled beclametasone who are not under the care of a specialist respiratory physician*
- *the percentage of patients in whom there has been documented consideration of downward dose titration for inhaled corticosteroid*
- *the percentage of patients using >800 micrograms/day of inhaled beclametasone without documented consideration of add-on therapy*
- *the percentage of patients in whom there has been documented consideration of downward dose titration for inhaled corticosteroid.*

Inhaler devices

Audit the percentage of patients in whom there is a record of satisfactory inhaler technique.

Audit the percentage of patients using a spacer device for mild to moderately severe exacerbations.

Management of acute asthma

Audit the percentage of patients in whom key steps in the management of acute asthma have been followed, for example, the percentage with a PEF measurement, the percentage with a justified X-ray on admission to hospital, or the percentage receiving corticosteroid tablets in adequate dosage and duration.

Asthma in pregnancy

Audit:

- *the percentage of pregnant women with documented discussion of the need to continue β_2 agonists and inhaled corticosteroid medication in pregnancy*
- *the percentage of pregnant women and partners who smoke with documented advice on smoking cessation.*

Occupational asthma

Audit the number of adults with adult-onset asthma for whom an occupational cause has been considered.

Organisation and delivery of care

Audit:

- *the percentage of clinicians who have taken part in suitable asthma educational update within last two years*
- *the percentage of patients reviewed annually. Consider focusing on particular groups such as those overusing bronchodilators, patients on higher treatment steps, those with exacerbations or from groups with more complex needs*
- *asthma outcomes in relevant subgroups of the population*
- *the percentage of inpatients receiving care from specialist asthma nurse or chest physician*
- *the percentage of patients treated according to key guideline recommendations*
- *the percentage of people receiving specialist nurse advice including self management planning before discharge*
- *the percentage of people reviewed within 30 days after hospital attendance with acute exacerbation of asthma.*

Patient education and self management

Audit the percentage of patients receiving written action plans.

Concordance and compliance

Audit prescription requests to determine compliance.

9 Patient education and self management

9.1 SELF-MANAGEMENT EDUCATION AND PERSONALISED ASTHMA ACTION PLANS

Written personalised action plans as part of self management education have been shown to improve health outcomes for people with asthma.^{407,678,679,682,690-710} The evidence is particularly good for those in secondary care with moderate to severe disease, and those who have had recent exacerbations where successful interventions have reduced hospitalisations and emergency department attendances in people with severe asthma.^{682,705,711,712} A consistent finding in many studies has been improvement in patient outcomes such as self-efficacy, knowledge and confidence.^{690,701-703,709,713-727} 1+

A Patients with asthma should be offered self-management education that focuses on individual needs, and be reinforced by a written personalised action plan.

A Prior to discharge, in-patients should receive written personalised action plans, given by clinicians with expertise in asthma management.

9.1.1 COMPONENTS OF A SELF MANAGEMENT PROGRAMME

Self management education is a multi-faceted intervention with wide variation in the construction of programmes.^{728,729} One systematic review has identified key components associated with beneficial outcome (see *Table 13*).⁷³⁰ While self management programmes are effective, individual components are not effective in isolation reinforcing the need to support the provision of personalised action plans with patient education.^{728,731} 1+

Successful programmes vary considerably, but encompass:

- Structured education, reinforced with written personal action plans, though the duration, intensity and format for delivery may vary.^{690,729}
- Specific advice about recognising loss of asthma control, though this may be assessed by symptoms or peak flows or both.^{678,679,690,692,696-698,728,730,732-735}
- Actions, summarised as two or three action points, to take if asthma deteriorates, including seeking emergency help, commencing oral steroids (which may include provision of an emergency course of steroid tablets) recommencing or temporarily increasing inhaled steroids, as appropriate to clinical severity.⁷³⁰

Some published studies report long, intensive programmes.^{709,736-738} However, there is evidence that short programmes are as effective,^{679,739} and that usual care can be raised to a standard that incorporates many of the core elements of the successful extensive programmes.^{740,741} 1+

A Introduce personalised action plans as part of a structured educational discussion.

Checklist 1. Suggested content for an educational programme/discussion

This checklist is intended as an example, which health professionals should adapt to meet the needs of individual patients and/or carers. The purpose of education is to empower patients and/or carers to undertake self management more appropriately and effectively. Information given should be tailored to individual patient's social, emotional and disease status, and age. Different approaches are needed for different ages.

- Nature of the disease
- Nature of the treatment
- Identify areas where patient most wants treatment to have effect
- How to use the treatment
- Development of self monitoring/self assessment skills
- Negotiation of the personalised action plan in light of identified patient goals
- Recognition and management of acute exacerbations
- Appropriate allergen or trigger avoidance.

9.1.2 SELF MANAGEMENT PROGRAMMES IN SPECIFIC PATIENT GROUPS

A range of different patient populations are included in the trials. It cannot be assumed that a successful intervention in one setting will be feasible or appropriate in another. The greatest benefits are shown in those managed in secondary care.^{682,711,712} Primary care studies have also shown benefit,^{698,700,702,741} though effects are weaker, perhaps because clinical benefit is harder to demonstrate in people with mild asthma. Innovative approaches to self management education in teenagers (web-based, peer delivered within schools) appear to have more success than more traditional programmes.^{699-701,706,709,742-744} A different approach may be needed for pre-school children, many of whom have viral induced wheeze.^{683,745,746} There are no studies which specifically address the provision of self-management education to the elderly. Sub group analyses from UK trials have suggested that existing self-management programmes may be of less benefit in ethnic minority groups, but there is a lack of studies evaluating more appropriate interventions.^{698,705}

Self management programmes will only achieve better health outcomes if the prescribed asthma treatment is appropriate and within guideline recommendations.^{713,717} There is some evidence that ownership of a self management plan may attract better treatment (ie increased steroid provision from attending physicians).^{682,698,701}

9.2 COMPLIANCE AND CONCORDANCE

The term compliance embodies a traditional model of prescriptive care which refers to the objectively measured usage of prescribed medication, or frequency of monitoring. Non-compliance may be intentional or unintentional. The term 'concordance' signifies a negotiated agreement between the professional and the patient. Non-concordance describes an inability of both parties to come to an understanding, not merely a failure of the patient to follow the health professional's instructions.⁷⁴⁷ Studies which assess whether or not the patient believes that their behaviour is appropriate find correlations between beliefs about illness and medicine and concordance.^{748,749} Achieving concordance is likely to improve (though not guarantee) compliance.

9.2.1 COMPLIANCE WITH MONITORING AND TREATMENT

Compliance with regular monitoring with peak flow meters, even in clinical drug trials is poor, with recorded daily use as low as 6%.^{750, 751} The lack of evidence supporting long term peak flow monitoring,^{647, 735, 752, 753} however, does not negate the use of home charting at critical times: for example, at diagnosis and initial assessment, when assessing response to changes in treatment, as part of a personalised action plan during exacerbations.⁷³⁵ Comparison should be with the patients' best peak flow (not predicted).⁷³⁰

Patients are more likely to under-use than over-use treatment⁷⁵⁴⁻⁷⁵⁶ and under-use should be considered when there is a failure to control asthma symptoms. Patient self reporting and health care professional assessment both overestimate regular use of prophylactic medication.^{754, 755, 757} Computer repeat-prescribing systems, widely available in general practice, provide a good indication of adherence with prescribed asthma regimens. Electronic monitoring, whilst the most accurate method, is only practical in clinical drug trials.⁷⁵⁴

- ☒ Computer repeat-prescribing systems provide a useful index of compliance.
- ☒ Where the patient agrees with the health professional that the action is appropriate compliance is more likely.

9.2.2 INTERVENTIONS TO IMPROVE COMPLIANCE AND CONCORDANCE

Compliance can be improved by simple written instructions and reminders of when to use medication.⁷⁵⁸ There is a suggestion in the literature that interventions designed to improve communication between patients and health professionals achieve better programme adherence.^{625, 737, 759} Presenting important information first and repeating it can improve patient recall.⁷⁶⁰ Computer,⁷⁶¹ and innovative web-based self management programmes may increase use of regular medication.⁷⁶² Within managed care programmes, nurse-led telephone-based self management education supported by written information can increase the use of inhaled steroids.^{763, 764}

- ☒ Provide simple, verbal and written instructions and information on drug treatment for patients and carers.

There is insufficient evidence to make clear recommendations on how the broader issues of concordance may be improved. Some practical tips for improving compliance are given in checklist 2.

Checklist 2: Practical tips for improving concordance

Open-ended questions like "If we could make one thing better for your asthma what would it be?" may help to elicit a more patient-centred agenda.
 Make it clear you are listening and responding to the patient's concerns and goals.
 Reinforce practical information and negotiated treatment plans with written instruction.
 Consider reminder strategies.
 Recall patients who miss appointments.

9.3 IMPLEMENTATION IN PRACTICE

Successful interventions have been delivered by trained asthma healthcare professionals, in the UK usually doctors and nurses, though a quality improvement programme which trained professionals in asthma self management showed no impact on clinical outcomes.^{678,679,690,692,694,765}

Three primary care studies explicitly link the provision of self management education with the facilitation of regular, structured review, consistent with the concept of 'guided self management'. All three increased ownership of personalised action plans and one showed a reduction in episodes of 'speech limiting wheeze'.^{631,741,766}

1+

B

Initiatives which encourage regular, structured review explicitly incorporating self management education should be used to increase ownership of personalised action plans.

9.4 PRACTICAL ADVICE

9.4.1 AVAILABLE RESOURCES

A number of resources are available to support health professionals, including the 'Be in Control' materials produced by Asthma UK. Annex 11 reproduces the Asthma UK personalised action plan available from their website www.asthma.org.uk/control. Additional support and information for patients and carers is also available from the Asthma UK website (www.asthma.org.uk) and their Adviceline run by asthma specialist nurses: 08457 01 02 03 which includes an interpreting service covering 22 languages and Typetalk.

9.4.2 GOOD PRACTICE POINTS

Every asthma consultation is an opportunity to review, reinforce and extend both knowledge and skills. This is true whether the patient is seen in primary care, the accident and emergency department or the outpatient clinic. It is important to recognise that education is a process and not a single event.



- A hospital admission represents a window of opportunity to review self management skills. No patient should leave hospital without a written personalised action plan and the benefit may be greatest at first admission.
- An acute consultation offers the opportunity to determine what action the patient has already taken to deal with the exacerbation. Their self management strategy may be reinforced or refined and the need for consolidation at a routine follow up considered.
- A consultation for an upper respiratory tract infection or other known trigger is an opportunity to rehearse with the patient their self management in the event of their asthma deteriorating.
- Brief simple education linked to patient goals is most likely to be acceptable to patients.

Table 13. Summary of the key components of a personalised action plan (adapted from Gibson et al)⁷³⁰

Component of an action plan	Result	Practical considerations
<p><i>Format of action points:</i></p> <p>Symptom vs peak flow triggered</p> <p>Standard written instructions</p> <p>Traffic light configuration</p>	<p>Similar effect</p> <p>Consistently beneficial</p> <p>Not clearly better than standard instructions</p>	<p>Asthma UK action plans include both symptom triggers and peak flow levels at which action should be taken.</p>
<p><i>Number of action points</i></p> <p>2-3 action points</p> <p>4 action points</p>	<p>Consistently beneficial</p> <p>Not clearly better than 2-3 points</p>	<p>Usual action points are:</p> <p>PEF < 80% best: increase inhaled steroids</p> <p>PEF < 60% best: commence oral steroids</p> <p>PEF < 40% best: seek urgent medical advice</p>
<p><i>Peak expiratory flow (PEF) levels</i></p> <p>Based on percentage personal best PEF</p> <p>Based on percentage predicted PEF</p>	<p>Consistently beneficial</p> <p>Not consistently better than usual care</p>	<p>Personal best should be assessed once treatment has been optimised and peak flows are stable.</p> <p>Best peak flow should be updated every few years in adults, and more frequently in growing children.</p>
<p><i>Treatment instructions</i></p> <p>Individualised using inhaled and oral steroids</p> <p>Individualised using oral steroids only</p> <p>Individualised using inhaled steroids</p>	<p>Consistently beneficial</p> <p>Insufficient data to evaluate</p> <p>Insufficient data to evaluate</p>	<p>Patients may safely hold an emergency supply of prednisolone tablets for use if their symptoms continue to deteriorate and/or if their peak flow falls to 60% of their best.</p> <p>Increasing inhaled steroids is ineffective if patients are already taking moderate or high doses (≥ 400 mcg daily) and these patients should be advised to move straight to the oral steroid step.</p> <p>Those on low doses (eg 200 mcg) of inhaled steroids may be advised to increase the dose substantially (eg to 1,200 mcg daily) at the onset of a deterioration.⁶³¹</p> <p>Any patients who have stopped medication should be reminded to recommence their inhaled steroids.</p>

10 Development of the guideline

10.1 INTRODUCTION

The guideline has been developed by multidisciplinary groups of practising clinicians using a standard methodology based on a systematic review of the evidence. Further details about SIGN and the guideline development methodology are contained in “SIGN 50: A Guideline Developer’s Handbook”, available at www.sign.ac.uk

Development involved the work of ten different multidisciplinary evidence review groups, a steering group and an executive group, chaired jointly by Dr Bernard Higgins on behalf of the BTS and Dr Graham Douglas on behalf of SIGN.

All members of the guideline development group made declarations of interest and further details of these are available on request from the SIGN Executive. Guideline development and literature review expertise, support and facilitation were provided by the SIGN Executive.

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Asthma in pregnancy

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10.5 SYSTEMATIC LITERATURE REVIEW

The evidence base for this guideline built on the reviews carried out for the original (2003) version of the guideline and subsequent updates.

All searches covered the Cochrane Library, Embase, and Medline. See Annex 1 for details of the time period covered for each topic. A copy of the search narrative, including listings of strategies, is available on the SIGN website as part of the supporting material for this guideline.

10.6 CONSULTATION AND PEER REVIEW

10.6.1 CONSULTATION

The most recent changes to this guideline were presented for discussion in draft form at the Winter Meeting of the British Thoracic Society in December 2008. The draft guideline was also available on the SIGN and BTS websites for a limited period at this stage to allow those unable to attend the meeting to contribute to the development of the guideline.

10.6.2 SPECIALIST REVIEWERS

The guideline was also reviewed in draft form by the following independent expert referees, who were asked to comment primarily on the comprehensiveness and accuracy of interpretation of the evidence base supporting the recommendations in the guideline. SIGN and the BTS are very grateful to all of these experts for their contribution to the guideline.

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Abbreviations

ABG	arterial blood gas
ABPA	allergic bronchopulmonary aspergillosis
ACT	Asthma Control Test
ACTH	adrenocorticotrophic hormone
AQLQ	Asthma Quality of Life Questionnaire
BDP	beclometasone
BTS	British Thoracic Society
COPD	chronic obstructive pulmonary disease
CXR	chest X-ray
DPI	dry powder inhaler
ED	emergency department
ETS	environmental tobacco smoke
FENO	exhaled nitric oxide concentration
FEV₁	forced expiratory volume in one second
FVC	forced vital capacity
GMS	General Medical Services
GP	general practitioner
GRASSIC	Grampian Asthma Study in Integrated Care
HDU	high dependency unit
ICU	intensive care unit
IM	intramuscular
IOS	impulse oscillometry
LABA	long-acting β_2 agonist
MDI	metered dose inhaler
MHRA	Medicines and Healthcare products Regulatory Agency
n-3PUFA	omega-3 polyunsaturated fatty acid
NIV	non-invasive ventilation
NSAIDS	Non-steroidal anti-inflammatory drugs
PaCO₂	partial pressure of carbon dioxide in arterial blood
PaO₂	partial pressure of oxygen in arterial blood
PC20	the provocative concentration of bronchoconstrictor (eg methacholine) required to cause a 20% fall in FEV ₁
PD20	the provocative dose of bronchoconstrictor (eg methacholine) required to cause a 20% fall in FEV ₁
PEF	peak expiratory flow
PEF A%H	peak expiratory flow amplitude percent highest
PICU	paediatric intensive care unit
PN	practice nurse
ppb	parts per billion
QOF	Quality and Outcomes Framework
RCP	Royal College of Physicians
RCT	randomised controlled trial
RV	residual volume
SIGN	Scottish Intercollegiate Guidelines Network
SpO₂	saturation of peripheral oxygen
sRaw	specific airways resistance
VE_{max}	ventilation at maximal exercise capacity

Annex 1

Summary of search histories by section

Literature searches to support the various sections of this guideline are conducted on a rolling basis. This summary indicates the currency of the searches supporting each section. Searches in all databases began with the earliest year available at that time, which varied from database to database; for example, searches in Embase extended back to 1980 and in CINAHL to 1982. Specific date coverage is provided for Medline. Detailed search strategies are available on the SIGN website in the supplementary material section.

Section 2 Diagnosis

Diagnosis in children

The search was last updated in April 2007. Coverage in Medline extends from 2003-2006. This search supplemented the broader search on diagnosis conducted for the original 2003 diagnosis section.

Diagnosis in adults; monitoring

The search was last updated in February 2006. Coverage in Medline extends from 1966-2005.

Section 3 Non-pharmacological management

The search was last updated in February 2006. Coverage in Medline extends from 1966-2005.

Section 4 Pharmacological management

The search was last updated in June 2008. Coverage in Medline extends from 1966-May 2008.

Section 5 Inhaler devices

The search was last updated in June 2008. Coverage in Medline extends from 1998-January 2008.

Section 6 Management of acute asthma

The search was last updated in June 2008. Coverage in Medline extends from 1966-2008.

Section 7 Special situations

Difficult asthma

The search was conducted in July 2007 and covered 1996-June 2007.

Asthma in pregnancy

The search was last updated in June 2008. Coverage in Medline extends from 1966-January 2008.

Occupational asthma

The search was last updated by SIGN in March 2003. In 2005, a systematic review by the British Occupational Health Research Foundation was used as the basis for updating this section.

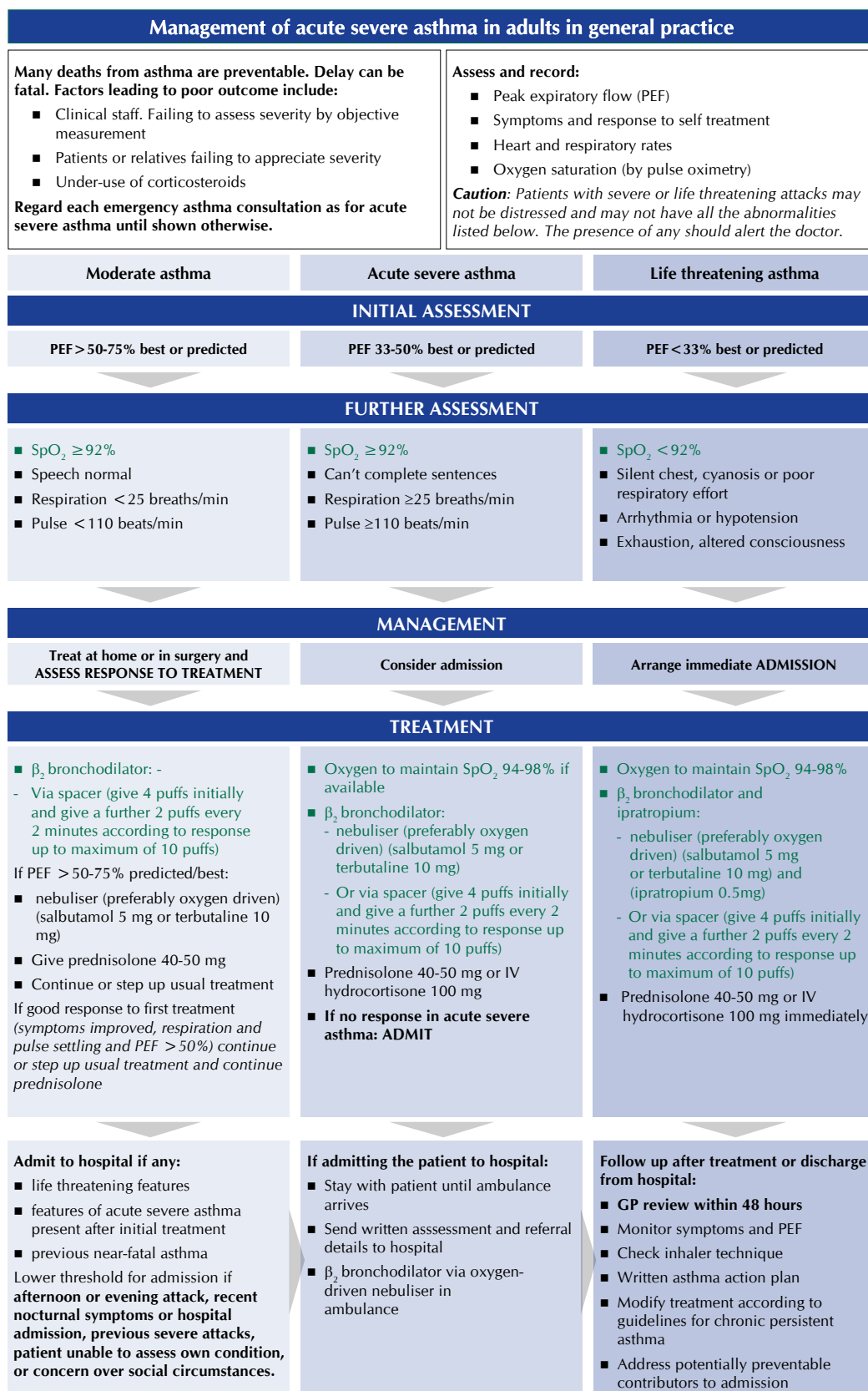
Section 8 Organisation and delivery of care, and audit

The search was last updated in March 2003. Coverage in Medline extends from 1966-2003.

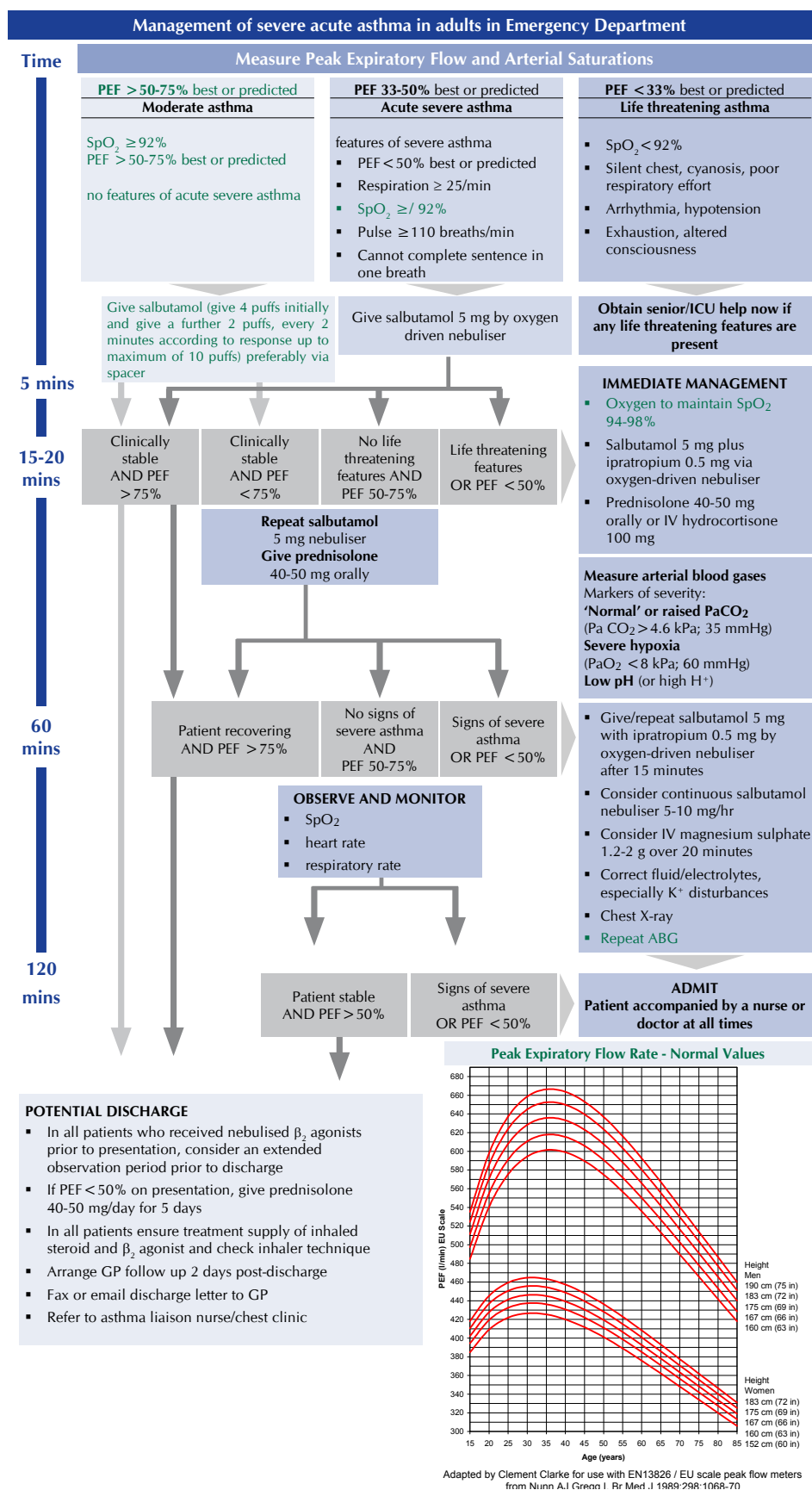
Section 9 Patient education and self management

The search was last updated in February 2006. Coverage in Medline extends from 1966-2005.

Annex 2



Annex 3



Annex 4

Management of acute severe asthma in adults in hospital

Features of acute severe asthma

- Peak expiratory flow (PEF) 33-50% of best (use % predicted if recent best unknown)
- Can't complete sentences in one breath
- Respirations ≥ 25 breaths/min
- Pulse ≥ 110 beats/min

Life threatening features

- PEF $< 33\%$ of best or predicted
- SpO₂ $< 92\%$
- Silent chest, cyanosis, or feeble respiratory effort
- Arrhythmia or hypotension
- Exhaustion, altered consciousness

If a patient has any life threatening feature, measure arterial blood gases. No other investigations are needed for immediate management.

Blood gas markers of a life threatening attack:

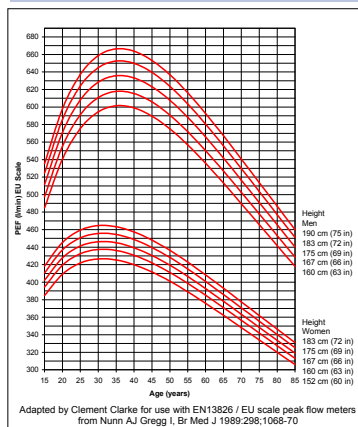
- 'Normal' (4.6-6 kPa, 35-45 mmHg) PaCO₂
- Severe hypoxia: PaO₂ < 8 kPa (60mmHg) irrespective of treatment with oxygen
- A low pH (or high H⁺)

Caution: Patients with severe or life threatening attacks may not be distressed and may not have all these abnormalities. The presence of any should alert the doctor.

Near fatal asthma

- Raised PaCO₂
- Requiring mechanical ventilation with raised inflation pressures

Peak Expiratory Flow Rate - Normal Values



IMMEDIATE TREATMENT

- Oxygen to maintain SpO₂ 94-98%
- Salbutamol 5 mg or terbutaline 10 mg via an oxygen-driven nebuliser
- Ipratropium bromide 0.5 mg via an oxygen-driven nebuliser
- Prednisolone tablets 40-50 mg or IV hydrocortisone 100 mg
- No sedatives of any kind
- Chest X ray if pneumothorax or consolidation are suspected or patient requires mechanical ventilation

IF LIFE THREATENING FEATURES ARE PRESENT:

- Discuss with senior clinician and ICU team
- Consider IV magnesium sulphate 1.2-2 g infusion over 20 minutes (unless already given)
- Give nebulised β_2 agonist more frequently e.g. salbutamol 5 mg up to every 15-30 minutes or 10 mg per hour via continuous nebulisation (requires special nebuliser)

SUBSEQUENT MANAGEMENT

IF PATIENT IS IMPROVING continue:

- Oxygen to maintain SpO₂ 94-98%
- Prednisolone 40-50mg daily or IV hydrocortisone 100 mg 6 hourly
- Nebulised β_2 agonist and ipratropium 4-6 hourly

IF PATIENT NOT IMPROVING AFTER 15-30 MINUTES:

- Continue oxygen and steroids
- Use continuous nebulisation of salbutamol at 5-10 mg/hour if an appropriate nebuliser is available. Otherwise give nebulised salbutamol 5 mg every 15-30 minutes
- Continue ipratropium 0.5 mg 4-6 hourly until patient is improving

IF PATIENT IS STILL NOT IMPROVING:

- Discuss patient with senior clinician and ICU team
- Consider IV magnesium sulphate 1.2-2 g over 20 minutes (unless already given)
- Senior clinician may consider use of IV β_2 agonist or IV aminophylline or progression to mechanical ventilation

MONITORING

- Repeat measurement of PEF 15-30 minutes after starting treatment
- Oximetry: maintain SpO₂ $> 94-98\%$
- Repeat blood gas measurements within 1 hour of starting treatment if:
 - initial PaO₂ < 8 kPa (60 mmHg) unless subsequent SpO₂ $> 92\%$
 - PaCO₂ normal or raised
 - patient deteriorates
- Chart PEF before and after giving β_2 agonists and at least 4 times daily throughout hospital stay

Transfer to ICU accompanied by a doctor prepared to intubate if:

- Deteriorating PEF, worsening or persisting hypoxia, or hypercapnea
- Exhaustion, altered consciousness
- Poor respiratory effort or respiratory arrest

DISCHARGE

When discharged from hospital, patients should have:

- Been on discharge medication for 12-24 hours and have had inhaler technique checked and recorded
- PEF $> 75\%$ of best or predicted and PEF diurnal variability $< 25\%$ unless discharge is agreed with respiratory physician
- Treatment with oral and inhaled steroids in addition to bronchodilators
- Own PEF meter and written asthma action plan
- GP follow up arranged within 2 working days
- Follow up appointment in respiratory clinic within 4 weeks

Patients with severe asthma (indicated by need for admission) and adverse behavioural or psychosocial features are at risk of further severe or fatal attacks

- Determine reason(s) for exacerbation and admission
- Send details of admission, discharge and potential best PEF to GP

Management of acute asthma in children in general practice

Age 2-5 years

ASSESS ASTHMA SEVERITY

Moderate asthma	Severe asthma	Life threatening asthma
<ul style="list-style-type: none"> ■ SpO₂ ≥92 % ■ Able to talk ■ Heart rate ≤140/min ■ Respiratory rate ≤40/min 	<ul style="list-style-type: none"> ■ SpO₂ <92 % ■ Too breathless to talk ■ Heart rate >140/min ■ Respiratory rate >40/min ■ Use of accessory neck muscles 	<ul style="list-style-type: none"> ■ SpO₂ <92 % plus any of: ■ Silent chest ■ Poor respiratory effort ■ Agitation ■ Altered consciousness ■ Cyanosis
<ul style="list-style-type: none"> ■ β₂ agonist 2-10 puffs via spacer ± facemask ■ Consider soluble prednisolone 20 mg 	<ul style="list-style-type: none"> ■ Oxygen via face mask ■ 2-10 puffs of β₂ agonist [give 2 puffs, every 2 minutes according to response up to maximum of 10 puffs] or nebulised salbutamol 2.5 mg or terbutaline 5 mg ■ Soluble prednisolone 20 mg 	<ul style="list-style-type: none"> ■ Oxygen via face mask ■ Nebulise: <ul style="list-style-type: none"> - salbutamol 2.5 mg or terbutaline 5 mg + - ipratropium 0.25 mg ■ Soluble prednisolone 20 mg or IV hydrocortisone 50 mg
<p>Increase β₂ agonist dose by 2 puffs every 2 minutes according to response up to 10 puffs</p>	<p>Assess response to treatment 15 mins after β₂ agonist</p>	
IF POOR RESPONSE ARRANGE ADMISSION	IF POOR RESPONSE REPEAT β ₂ AGONIST AND ARRANGE ADMISSION	REPEAT β ₂ AGONIST VIA OXYGEN-DRIVEN NEBULISER WHILST ARRANGING IMMEDIATE HOSPITAL ADMISSION
GOOD RESPONSE <ul style="list-style-type: none"> ■ Continue β₂ agonist via spacer or nebuliser, as needed but not exceeding 4-hourly ■ If symptoms are not controlled repeat β₂ agonist and refer to hospital ■ Continue prednisolone for up to 3 days ■ Arrange follow-up clinic visit 	POOR RESPONSE <ul style="list-style-type: none"> ■ Stay with patient until ambulance arrives ■ Send written assessment and referral details ■ Repeat β₂ agonist via oxygen-driven nebuliser in ambulance 	
LOWER THRESHOLD FOR ADMISSION IF: <ul style="list-style-type: none"> ■ Attack in late afternoon or at night ■ Recent hospital admission or previous severe attack ■ Concern over social circumstances or ability to cope at home 		
NB: If a patient has signs and symptoms across categories, always treat according to their most severe features		

Age > 5 years

ASSESS ASTHMA SEVERITY

Moderate asthma	Severe asthma	Life threatening asthma
<ul style="list-style-type: none"> ■ SpO₂ ≥92 % ■ PEF ≥ 50 % best or predicted ■ Able to talk ■ Heart rate ≤125/min ■ Respiratory rate ≤30/min 	<ul style="list-style-type: none"> ■ SpO₂ <92 % ■ PEF 33-50 % best or predicted ■ Too breathless to talk ■ Heart rate >125/min ■ Respiratory rate >30/min ■ Use of accessory neck muscles 	<ul style="list-style-type: none"> ■ SpO₂ <92 % plus any of: ■ PEF <33 % best or predicted ■ Silent chest ■ Poor respiratory effort ■ Agitation ■ Altered consciousness ■ Cyanosis
<ul style="list-style-type: none"> ■ β₂ agonist 2-10 puffs via spacer ■ Consider soluble prednisolone 30-40 mg 	<ul style="list-style-type: none"> ■ Oxygen via face mask ■ 2-10 puffs of β₂ agonist [give 2 puffs, every 2 minutes according to response up to maximum of 10 puffs] or nebulised salbutamol 2.5-5 mg or terbutaline 5-10 mg ■ Soluble prednisolone 30-40 mg 	<ul style="list-style-type: none"> ■ Oxygen via face mask ■ Nebulise: <ul style="list-style-type: none"> - salbutamol 5 mg or terbutaline 10 mg + - ipratropium 0.25 mg ■ Soluble prednisolone 30-40 mg or IV hydrocortisone 100 mg
<p>Increase β₂ agonist dose by 2 puffs every 2 minutes according to response up to 10 puffs</p>	<p>Assess response to treatment 15 mins after β₂ agonist</p>	
IF POOR RESPONSE ARRANGE ADMISSION	IF POOR RESPONSE REPEAT β ₂ AGONIST AND ARRANGE ADMISSION	REPEAT β ₂ AGONIST VIA OXYGEN-DRIVEN NEBULISER WHILST ARRANGING IMMEDIATE HOSPITAL ADMISSION
GOOD RESPONSE <ul style="list-style-type: none"> ■ Continue β₂ agonist via spacer or nebuliser, as needed but not exceeding 4-hourly ■ If symptoms are not controlled repeat β₂ agonist and refer to hospital ■ Continue prednisolone for up to 3 days ■ Arrange follow-up clinic visit 	POOR RESPONSE <ul style="list-style-type: none"> ■ Stay with patient until ambulance arrives ■ Send written assessment and referral details ■ Repeat β₂ agonist via oxygen-driven nebuliser in ambulance 	
LOWER THRESHOLD FOR ADMISSION IF: <ul style="list-style-type: none"> ■ Attack in late afternoon or at night ■ Recent hospital admission or previous severe attack ■ Concern over social circumstances or ability to cope at home 		
NB: If a patient has signs and symptoms across categories, always treat according to their most severe features		

Annex 5

Annex 6

Management of acute asthma in children in Emergency Department

Age 2-5 years

ASSESS ASTHMA SEVERITY

Moderate asthma <ul style="list-style-type: none">▪ SpO₂ ≥ 92%▪ No clinical features of severe asthma NB: If a patient has signs and symptoms across categories, always treat according to their most severe features	Severe asthma <ul style="list-style-type: none">▪ SpO₂ < 92%▪ Too breathless to talk or eat▪ Heart rate > 140/min▪ Respiratory rate > 40/min▪ Use of accessory neck muscles	Life threatening asthma <ul style="list-style-type: none">▪ SpO₂ < 92% plus any of:<ul style="list-style-type: none">▪ Silent chest▪ Poor respiratory effort▪ Agitation▪ Altered consciousness▪ Cyanosis
---	--	---

Oxygen via face mask/nasal prongs to achieve SpO₂ 94-98%

<ul style="list-style-type: none">▪ β₂ agonist 2-10 puffs via spacer ± facemask (given one at a time single puffs, tidal breathing and inhaled separately)▪ Increase β₂ agonist dose by 2 puffs every 2 minutes up to 10 puffs according to response▪ Consider soluble oral prednisolone 20 mg	<ul style="list-style-type: none">▪ β₂ agonist 10 puffs via spacer ± facemask or nebulised salbutamol 2.5 mg or terbutaline 5 mg▪ Soluble prednisolone 20 mg or IV hydrocortisone 4 mg/kg▪ Repeat β₂ agonist up to every 20-30 minutes according to response▪ If poor response add 0.25 mg nebulised ipratropium bromide	<ul style="list-style-type: none">▪ Nebulised β₂ agonist: salbutamol 2.5 mg or terbutaline 5 mg plus ipratropium bromide 0.25 mg nebulised▪ Oral prednisolone 20mg or IV Hydrocortisone 4mg/kg if vomiting Discuss with senior clinician, PICU team or paediatrician <ul style="list-style-type: none">▪ Repeat bronchodilators every 20-30 minutes
--	--	---

Reassess within 1 hour

DISCHARGE PLAN

- Continue β₂ agonist 4 hourly pm
- Consider prednisolone 20 mg daily for up to 3 days
- Advise to contact GP if not controlled on above treatment
- Provide a written asthma action plan
- Review regular treatment
- Check inhaler technique
- Arrange GP follow up

Arrange immediate transfer to PICU/HDU if poor response to treatment
Admit all cases if features of severe exacerbation persist after initial treatment

Age > 5 years

ASSESS ASTHMA SEVERITY

Moderate asthma <ul style="list-style-type: none">▪ SpO₂ ≥ 92%▪ PEF ≥ 50% best or predicted▪ No clinical features of severe asthma NB: If a patient has signs and symptoms across categories, always treat according to their most severe features	Severe asthma <ul style="list-style-type: none">▪ SpO₂ < 92%▪ PEF 33-50% best or predicted▪ Heart rate > 125/min▪ Respiratory rate > 30/min▪ Use of accessory neck muscles	Life threatening asthma <ul style="list-style-type: none">▪ SpO₂ < 92% plus any of:<ul style="list-style-type: none">▪ PEF < 33% best or predicted▪ Silent chest▪ Poor respiratory effort▪ Altered consciousness▪ Cyanosis
---	---	--

Oxygen via face mask/nasal prongs to achieve SpO₂ 94-98%

<ul style="list-style-type: none">▪ β₂ agonist 2-10 puffs via spacer▪ Increase β₂ agonist dose by 2 puffs every 2 minutes up to 10 puffs according to response▪ Oral prednisolone 30-40 mg	<ul style="list-style-type: none">▪ β₂ agonist 10 puffs via spacer or nebulised salbutamol 2.5-5 mg or terbutaline 5-10 mg▪ Oral prednisolone 30-40 mg or IV hydrocortisone 4 mg/kg if vomiting▪ If poor response nebulised ipratropium bromide 0.25 mg▪ Repeat β₂ agonist and ipratropium up to every 20-30 minutes according to response	<ul style="list-style-type: none">▪ Nebulised β₂ agonist: salbutamol 5 mg or terbutaline 10 mg plus ipratropium bromide 0.25 mg nebulised▪ Oral prednisolone 30-40mg or IV Hydrocortisone 4mg/kg if vomiting Discuss with senior clinician, PICU team or paediatrician <ul style="list-style-type: none">▪ Repeat bronchodilators every 20-30 minutes
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Reassess within 1 hour

DISCHARGE PLAN

- Continue β₂ agonist 4 hourly as necessary
- Consider prednisolone 30-40 mg daily for up to 3 days
- Advise to contact GP if not controlled on above treatment
- Provide a written asthma action plan
- Review regular treatment
- Check inhaler technique
- Arrange GP follow up

Arrange immediate transfer to PICU/HDU if poor response to treatment
Admit all cases if features of severe exacerbation persist after initial treatment

Management of acute asthma in children in hospital

Age 2-5 years

ASSESS ASTHMA SEVERITY

ASSESS ASTHMA SEVERITY		
Moderate asthma <ul style="list-style-type: none"> SpO₂ \geq 92% No clinical features of severe asthma <p>NB: If a patient has signs and symptoms across categories, always treat according to their most severe features</p>	Severe asthma <ul style="list-style-type: none"> SpO₂ < 92% Too breathless to talk or eat Heart rate > 140/min Respiratory rate > 40/min Use of accessory neck muscles 	Life threatening asthma <p>SpO₂ < 92% plus any of:</p> <ul style="list-style-type: none"> Silent chest Poor respiratory effort Agitation Altered consciousness Cyanosis
Oxygen via face mask/nasal prongs to achieve SpO ₂ 94-98%		
<ul style="list-style-type: none"> β_2 agonist 2-10 puffs via spacer \pm facemask (given one at a time single puffs, tidal breathing and inhaled separately) Increase β_2 agonist dose by 2 puffs every 2 minutes up to 10 puffs according to response Consider soluble oral prednisolone 20 mg <p>Reassess within 1 hour</p>	<ul style="list-style-type: none"> β_2 agonist 10 puffs via spacer \pm facemask or nebulised salbutamol 2.5 mg or terbutaline 5 mg Soluble prednisolone 20 mg or IV hydrocortisone 4 mg/kg Repeat β_2 agonist up to every 20-30 minutes according to response If poor response add 0.25 mg nebulised ipratropium bromide 	<ul style="list-style-type: none"> Nebulised β_2 agonist: salbutamol 2.5 mg or terbutaline 5 mg plus ipratropium bromide 0.25 mg nebulised Oral prednisolone 20mg/ kg or IV hydrocortisone 4mg/ kg if vomiting Discuss with senior clinician, PICU team or paediatrician Repeat bronchodilators every 20-30 minutes

ASSESS RESPONSE TO TREATMENT
Record respiratory rate, heart rate and oxygen saturation every 1-4 hours

ASSESS RESPONSE TO TREATMENT Record respiratory rate, heart rate and oxygen saturation every 1-4 hours	
RESPONDING <ul style="list-style-type: none"> Continue bronchodilators 1-4 hours pm Discharge when stable on 4 hourly treatment Continue oral prednisolone for up to 3 days <p>At discharge</p> <ul style="list-style-type: none"> Ensure stable on 4 hourly inhaled treatment Review the need for regular treatment and the use of inhaled steroids Review inhaler technique Provide a written asthma action plan for treating future attacks Arrange follow up according to local policy 	NOT RESPONDING <ul style="list-style-type: none"> Arrange HDU/PICU transfer Consider: <ul style="list-style-type: none"> Chest X-ray and blood gases IV salbutamol 1.5 mcg/kg bolus over 10 minutes followed by continuous infusion 1-5 mcg/kg/min (dilute to 200 mcg/ml) IV aminophylline 5 mg/kg loading dose over 20 minutes (omit in those receiving oral theophyllines) followed by continuous infusion 1 mg/kg/hour

Age > 5 years

ASSESS ASTHMA SEVERITY

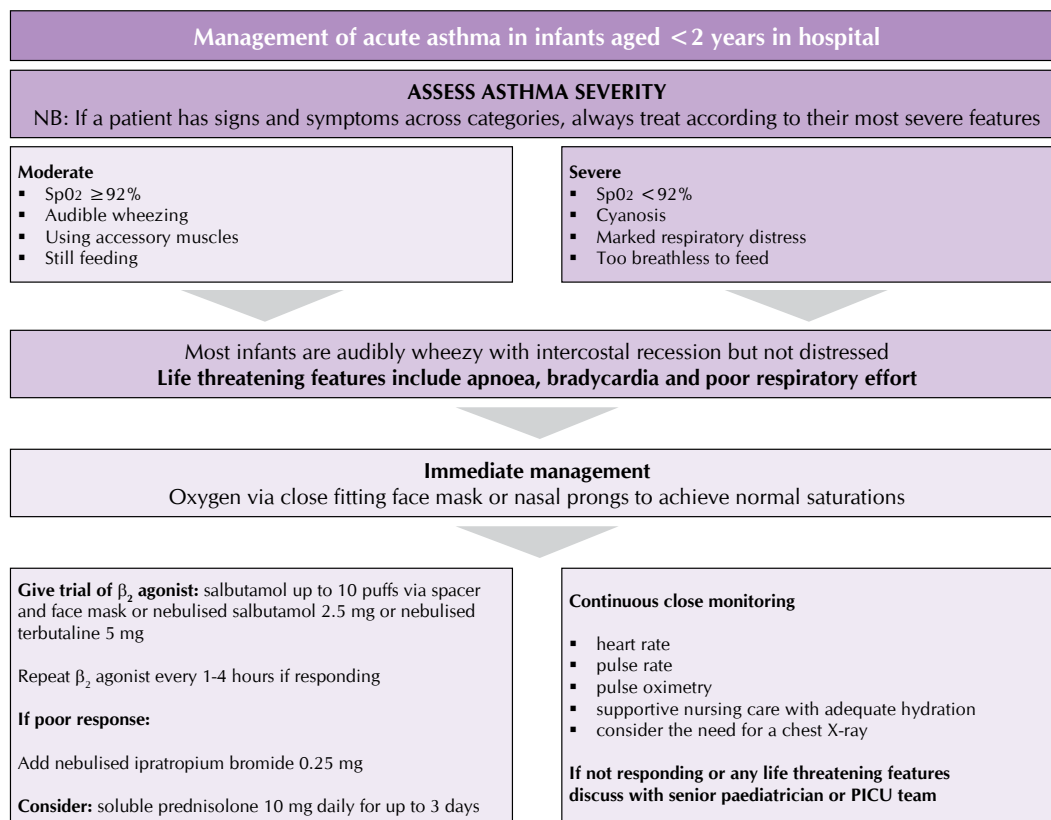
ASSESS ASTHMA SEVERITY		
Moderate asthma <ul style="list-style-type: none"> SpO₂ \geq 92% PEF > 50% best or predicted No clinical features of severe asthma <p>NB: If a patient has signs and symptoms across categories, always treat according to their most severe features</p>	Severe asthma <ul style="list-style-type: none"> SpO₂ < 92% PEF 33-50% best or predicted Heart rate > 125/min Respiratory rate > 30/min Use of accessory neck muscles 	Life threatening asthma <p>SpO₂ < 92% plus any of:</p> <ul style="list-style-type: none"> PEF < 33% best or predicted Silent chest Poor respiratory effort Altered consciousness Cyanosis
Oxygen via face mask/nasal prongs to achieve SpO ₂ 94-98%		
<ul style="list-style-type: none"> β_2 agonist 2-10 puffs via spacer Increase β_2 agonist dose by 2 puffs every 2 minutes up to 10 puffs according to response Oral prednisolone 30-40 mg <p>Reassess within 1 hour</p>	<ul style="list-style-type: none"> β_2 agonist 10 puffs via spacer or nebulised salbutamol 2.5-5 mg or terbutaline 5-10 mg Oral prednisolone 30-40 mg or IV hydrocortisone 4 mg/kg if vomiting If poor response nebulised ipratropium bromide 0.25 mg Repeat β_2 agonist and ipratropium up to every 20-30 minutes according to response 	<ul style="list-style-type: none"> Nebulised β_2 agonist: salbutamol 5 mg or terbutaline 10 mg plus ipratropium bromide 0.25 mg nebulised Oral prednisolone 30-40mg or IV hydrocortisone 4mg/kg if vomiting Discuss with senior clinician, PICU team or paediatrician Repeat bronchodilators every 20-30 minutes

ASSESS RESPONSE TO TREATMENT
Record respiratory rate, heart rate, oxygen saturation and PEF/FEV every 1-4 hours

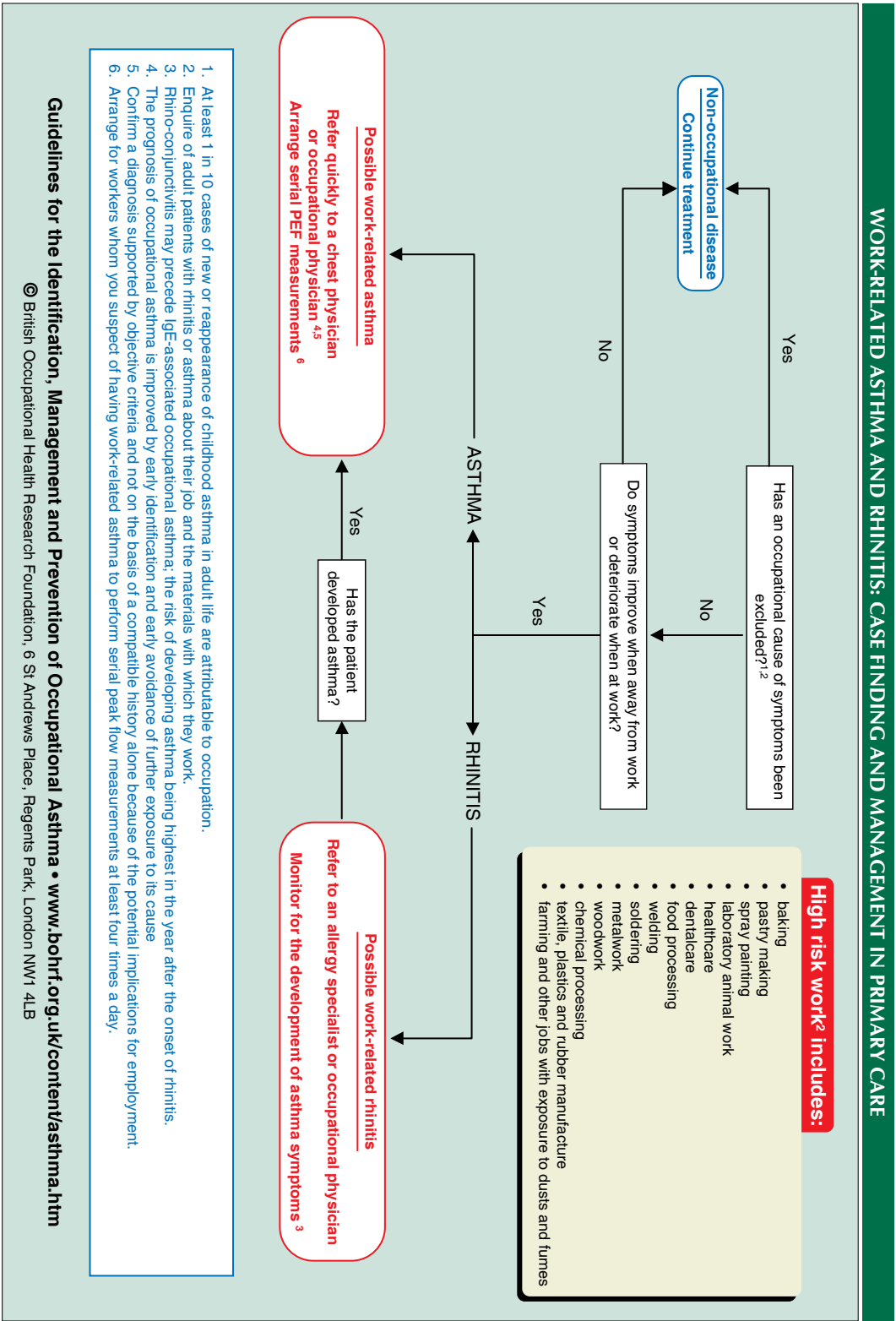
ASSESS RESPONSE TO TREATMENT Record respiratory rate, heart rate, oxygen saturation and PEF/FEV every 1-4 hours	
RESPONDING <ul style="list-style-type: none"> Continue bronchodilators 1-4 hours pm Discharge when stable on 4 hourly treatment Continue oral prednisolone 30-40 mg for up to 3 days <p>At discharge</p> <ul style="list-style-type: none"> Ensure stable on 4 hourly inhaled treatment Review the need for regular treatment and the use of inhaled steroids Review inhaler technique Provide a written asthma action plan for treating future attacks Arrange follow up according to local policy 	NOT RESPONDING <ul style="list-style-type: none"> Continue 20-30 minute nebulisers and arrange HDU/PICU transfer Consider: Chest X-ray and blood gases Consider risks and benefits of: <ul style="list-style-type: none"> Bolus IV salbutamol 1.5 mcg/kg if not already given Continuous IV salbutamol infusion 1-5 mcg/kg/min (200 mcg/ml solution) IV aminophylline 5 mg/kg loading dose over 20 minutes (omit in those receiving oral theophyllines) followed by continuous infusion 1mg/kg/hour Bolus IV infusion of magnesium sulphate 40 mg/kg (max 2 g) over 20 minutes

Annex 7

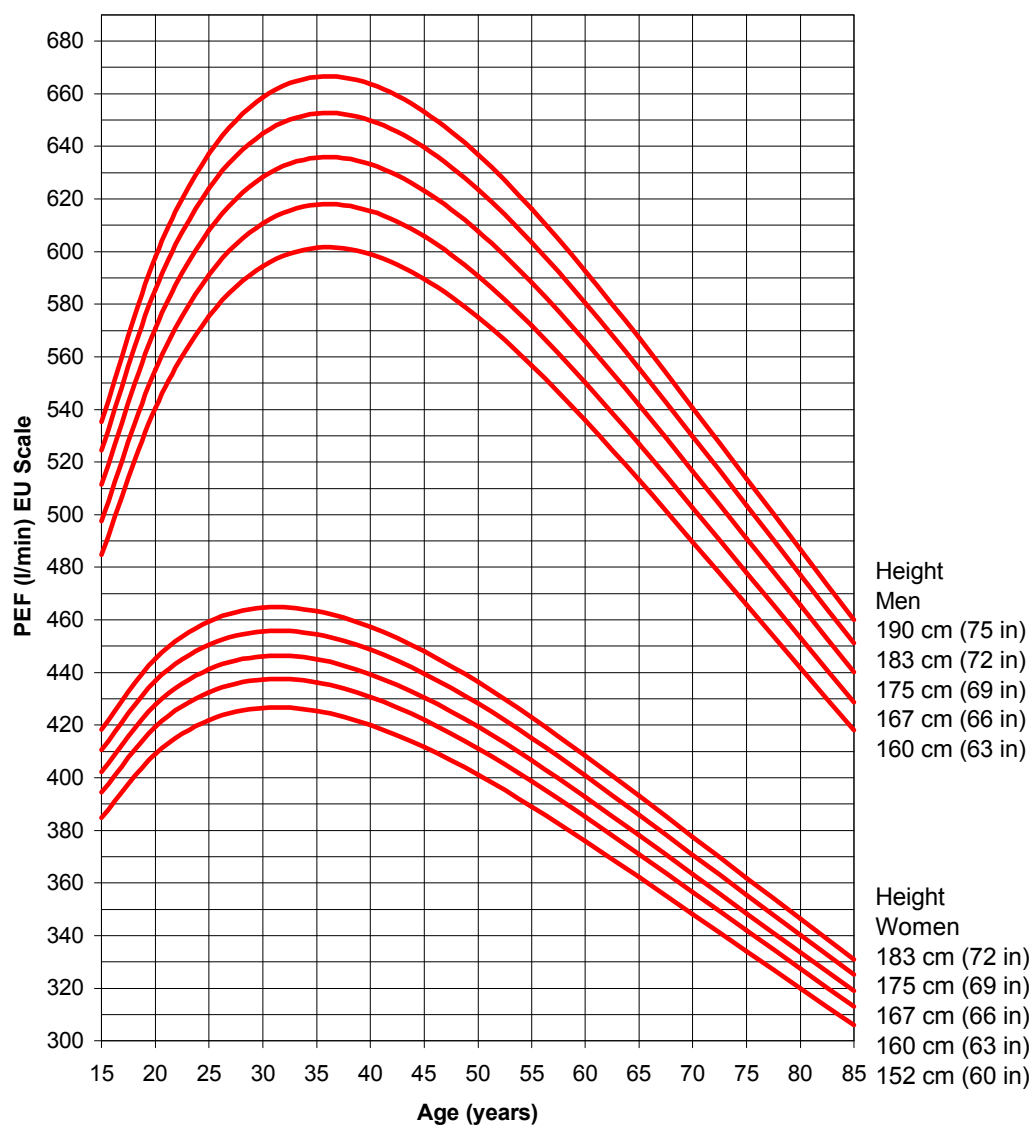
Annex 8



Annex 9



Annex 10



Adapted by Clement Clarke for use with EN13826 / EU scale peak flow meters
from Nunn AJ Gregg I, Br Med J 1989;298:1068-70

Annex 11

About your personal asthma action plan

This plan is intended to be used by people with asthma aged 12 and above.

Your doctor or nurse will fill in this plan with you and explain the different medicines that you should take to control your asthma. It shows you how to recognise when your asthma is getting worse and what you can do about it. It is reassuring to know that by taking steps early, severe asthma attacks can usually be prevented.

Updating your personal asthma action plan

Because your asthma symptoms can change from day to day, your doctor or nurse may need to change your plan. You should have your asthma reviewed at least once a year.

If your medicine has been changed or increased, visit your doctor or nurse after one month to review your asthma.

Do not stop taking your asthma medicines without talking to your doctor or nurse first.

What to do in an asthma attack

An emergency is when any of the following happen:

- 1 Your reliever (blue) inhaler does not help
- 2 Your symptoms get worse (tough, breathless, wheeze, tight chest)
- 3 You are too breathless to speak

What you must do during an attack:

- 1 Take your reliever (blue) inhaler
- 2 Sit up and loosen tight clothing
- 3 If no improvement, repeat step 1 or if necessary, take your red or white inhaler
- 4 If you are unable to get improvement in five minutes – call 999 or a doctor urgently

What you can do

Make sure you are taking your medicines as discussed with your doctor or nurse – this information should be written in this card.

Ask your doctor or nurse for a personal asthma action plan. This will help you to know what to do if your symptoms get worse or do not improve.

Personal asthma action plan

Be in control

Name	
Relationship to you	
Name of next of kin	Doctor or nurse contact number
Next of kin contact number	
Best peak flow and date taken	
Drug allergens	
Dates plan updated	
Notes	

What you can do

Make sure you are taking your medicines as discussed with your doctor or nurse – this information should be written in this card.

Ask your doctor or nurse for a personal asthma action plan. This will help you to know what to do if your symptoms get worse or do not improve.

Asthma UK website

Read the latest independent advice and news on asthma
asthma.org.uk

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Asthma UK advice line

Ask an asthma nurse specialist
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Request a personal asthma action plan and other specialist advice on every aspect of asthma
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Annex 11 (contd)

Date you started this diary		2021.12.21-2021.12.21
Have you had difficulty sleeping because of your asthma symptoms (waking cough)?		Y N
Have you had your usual asthma symptoms during the day (cough, wheeze, shortness of breath, etc)?		Y N
Has your asthma interfered with your usual activities (eg business, work or school)?		Y N
Your medicine is:		
How much?		
When?		
200 180 160 140 120		
700 600 500 400 300		
M T W T F S S M T W T F S S M T W T F S S M T W T F S S		

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